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TECHNA CORPORATION

Knowledge, and the Creativity to Use It

REMEDIAL INVESTIGATION
AND
BASELINE RISK ASSESSMENT
DRAFT REPORT

HI-MILL MANUFACTURING

HIGHLAND, MI

Prepared by:

Techna Corporation
44808 Helm Street
Plymouth, Michigan 48170

June 21, 1990

HI-MILL MANUFACTURING COMPANY

DRAFT REMEDIAL INVESTIGATION REPORT

AND

BASELINE RISK ASSESSMENT

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1.0 INTRODUCTION

1.1 Purpose of Report

The purpose of this Draft Remedial Investigation and Baseline Risk Assessment Report is to document the Remedial Investigation at the Hi-Mill National Priorities List (NPL) site as conducted in accordance with the Remedial Investigation Work Plan and to provide a basis for the Feasibility Study and other actions that may be required at the Hi-Mill site as consistent with the National Contingency Plan. This documentation includes a detailed description of field activities, a compilation or direct reference for all data collected during the Remedial Investigation, an analysis of data related to the Hi-Mill site, including the type and extent of contaminants, and an evaluation of the risks associated with the species and concentrations of contamination determined to be present at the Hi-Mill site.

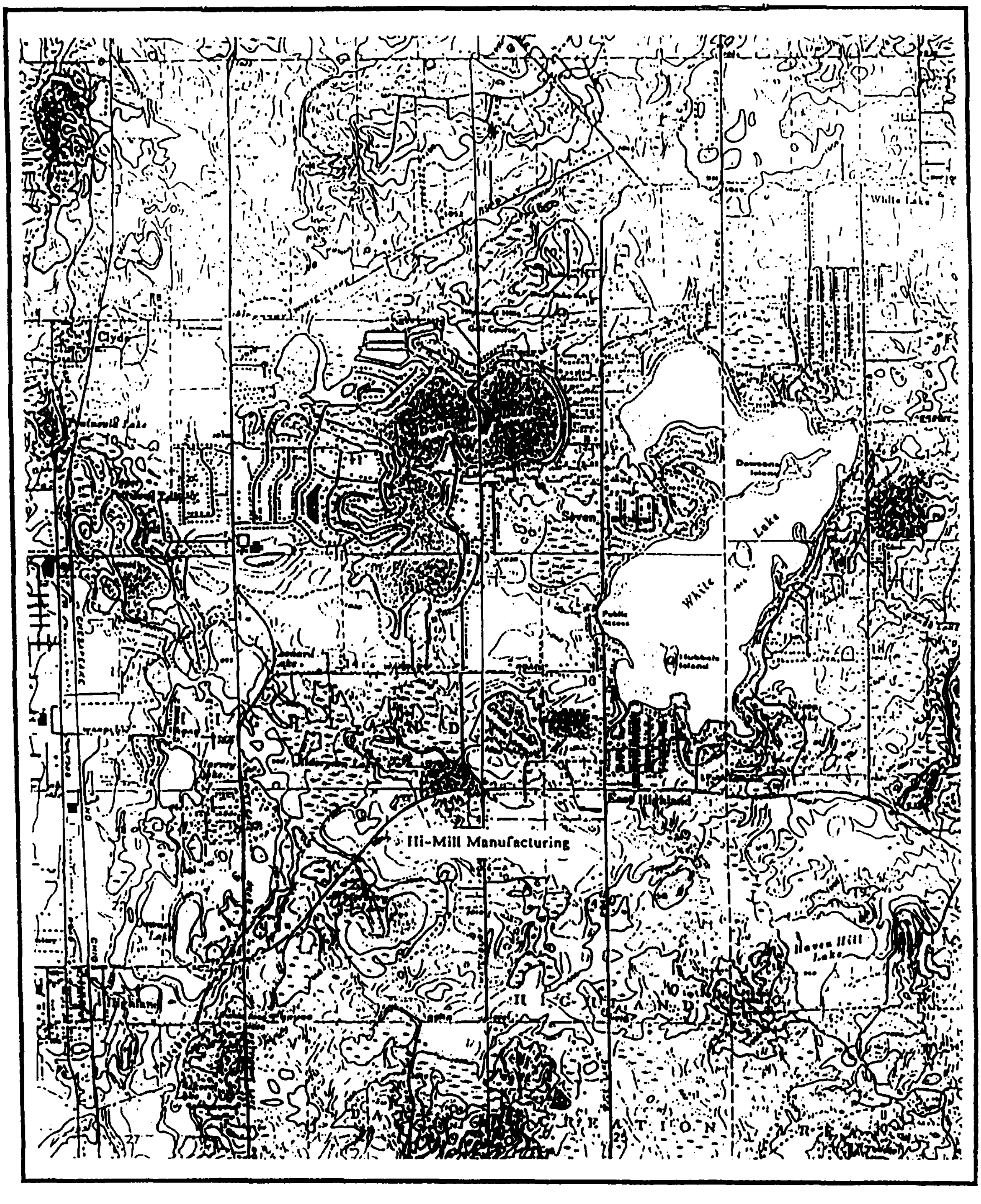
Subsection 1.2 of this section provides background information related to the site including a complete site description and summaries of previous investigations relevant to the Hi-Mill site. Subsection 1.3 of this section describes the overall organization of the remainder of this report.

1.2 Site Background

1.2.1 Site Description

The Hi-Mill Site is located in Highland Township, Oakland County, Michigan, approximately 1.5 miles east of the town of Highland (Figure 1-1). The plant address is 1704 Highland Road (M-59), which is located within Section 23, T7N R18W. The site occupies an irregularly shaped property of approximately 4.5 acres in size (Figure 1-2) which lies at an elevation of approximately 1010 feet above National Geodetic Vertical Datum (NGVD).

Figure 1-1. Site Location Map.



The Hi-Mill building and parking area occupy most of the site (Figure 1-2). The building lies in the northwest part of the property and is irregularly shaped, having been expanded severaltimes since its original construction in 1946. It houses the corporate and administrative offices, tubing production facilities and raw material storage and preparation areas. Paved parking areas occupy all of the property northeast of the production/office building and part of the site southwest of the building. The remainder of the property is covered with vegetation.

The Hi-Mill property is bounded to the northwest by Highland Road (M-59), a four-lane, divided highway. It is bounded on all other sides by the Highland State Recreation Area, which is owned and maintained by the Michigan Department of Natural Resources. A marsh/pond of approximately 8 - 10 acres in size lies east of the Hi-Mill property. A slightly elevated, vegetated plain and woodlands area lies south of the Hi-Mill property. Waterbury Lake lies approximately 900 - 1000 feet south of the Hi-Mill property, just beyond the slightly elevated plain.

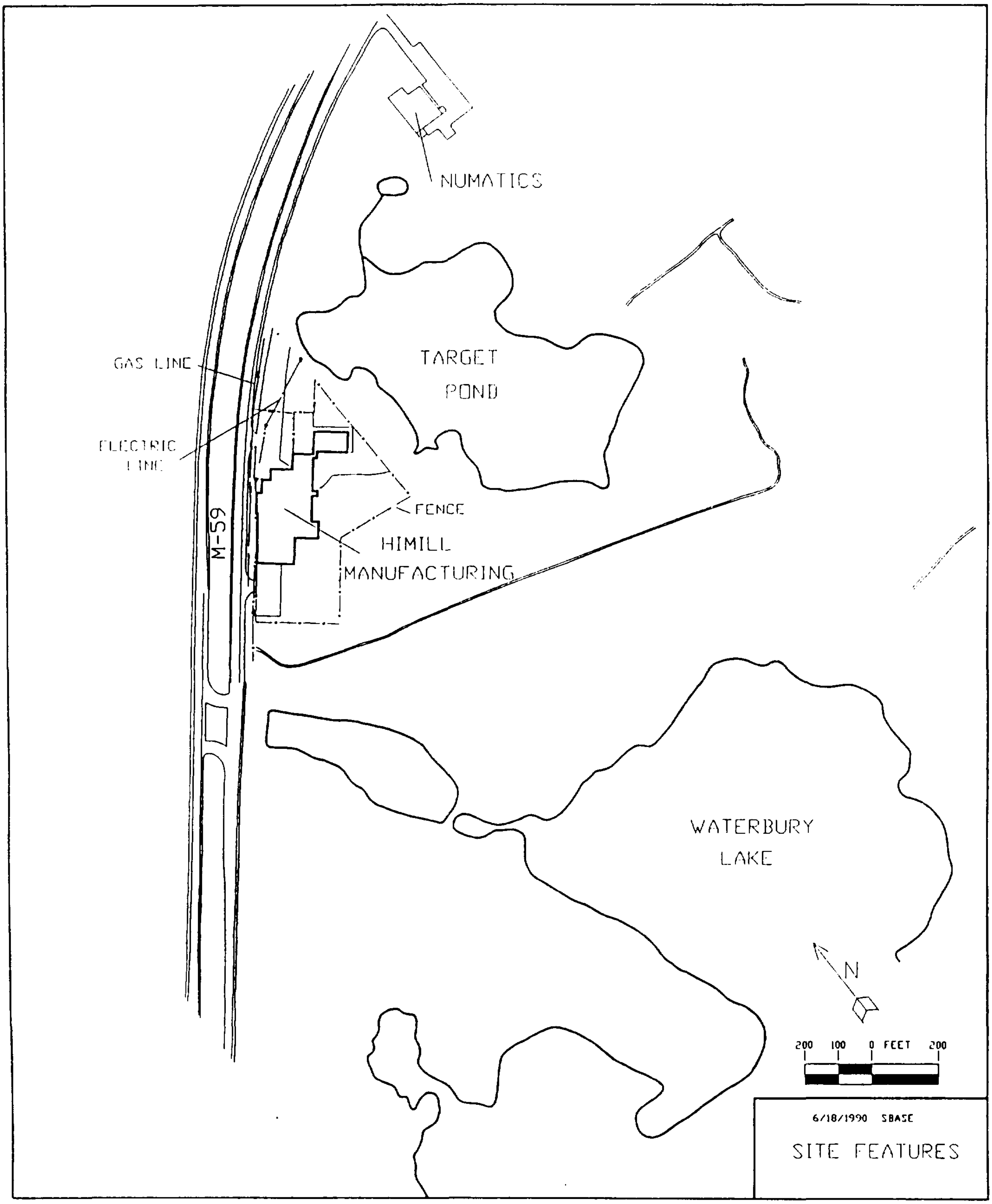
The immediate area around Hi-Mill is sparsely populated and rural in nature. The nearest dwellings lie approximately 2000 feet east and southeast of the site, along Waterbury Road. Numatics, Inc., 2000 Highland Road East, a manufacturer of metal air control valve parts, is located approximately 1000 feet northeast of the Hi-Mill property. Numatics, Inc. discharges process wastewater to a drain and tile field located on their property.

Highland Township is a rural/suburban area with a population of approximately 17,000 - 19,000. The rural/suburban nature of the township is reflected in the lack of large population or commercial centers and the absence of many city services. A majority of inhabitants obtain drinking water from domestic water wells and dispose of sewage through individual septic systems.

Surface topography and associated soil deposits in this region of southeastern Michigan result from glacial processes occurring during the Wisconsin Glacial Stage of the Pleistocene Series. Glacial action has deposited a mantle of glacial debris (soil), ranging in thickness from 225 feet to more than 300 feet. The stratigraphy of the glacial deposit is quite complex and represents materials deposited during successive advancements and retreats of the ice front(s).

The surface topography of the region is generally representative of the interlobate morainic system which lies on a northeast-southwest axis extending from approximately Jackson to Oxford. This morainic system results from interaction of the Saginaw, Huron and Erie Lobes. The Saginaw lobe

Figure 1-2. Site Features Map



advanced from the northwest, joining the Huron Lobe which advanced from the northeast and the Erie Lobe which advanced from the east.

Surface formations within the study area were formed primarily during retreat of these glacial ice lobes with the subsequent meltwater influencing much of the topography and near-surface soil deposits. Much of the area contains outwash material at the surface, deposited by glacial meltwaters.

Many closed depressions (kettles) dot the outwash sediments. These formed as a result of large blocks of ice, left behind by the rapidly receding glacier front, which were surrounded and covered by outwash sediments. As the buried or partially buried ice blocks melted, the sediments slumped into the resultant voids. This phenomenon is responsible for the pitted outwash topography evident in the study area. Kettles serve as basins for the numerous lakes and swamps found throughout the region.

The subsurface stratigraphy in the region is complex and is representative of variable climatic conditions throughout the period of glaciation. Soils encountered within the profile may be well-sorted granular materials representative of a period of rapid melting, lacustrine clay indicating the presence of a lake near the ice margin, ground moraines indicating a period of ice advance, as well as buried recessional moraines. Therefore, throughout most of the area, the general stratigraphy of the glacial deposits consists of regionally discontinuous interbedded layers of lacustrine clay, unsorted moraines and outwash deposits.

In general, the region can be characterized as having well defined surface moraines with moderate permeability, ground laid moraines and lacustrine clays with low permeability and outwash deposits ranging from moderate to high permeability. Where present, the finer grained soils serve as an aquiclude that provides a bottom seal for an unconfined surface aquifer. The clay aquicludes also serve as the top confining seal for some artesian aquifers within the general region.

Mississippian age Coldwater Shale underlies the glacial soil at estimated depths of 225 feet to 300 feet.

1.2.2 Site History

Since its formation in 1946, Hi-Mill Manufacturing Company has fabricated copper, aluminum and brass tubing parts and fittings. Production operations have included cutting, machining, forming, shaping and soldering of the raw tubing and fabricated tubing components. Support operations have included nitric and sulfuric acid cleaning and brightening, chromic acid washing, and chlorinated solvent degreasing. All soldering operations have used silver solder or aluminum bar brazing; no tin-lead solder has been used in Hi-Mill's operations. Hi-Mill typically employs between 40 and 60 persons in a single eight-hour shift five days per week.

Wastewater discharges occurred historically to two lagoons located southeast of the Hi-Mill building. From prior to 1960 (exact date unknown) until 1981, process wastewaters were discharged to an unlined lagoon approximately 90 x 90 feet square. The base of the lagoon, reportedly, was excavated approximately six feet into the underlying clay stratum. Process waters, consisting mainly of acid brightening solutions and acid brightening rinse waters, were discharged to the lagoons. In the Fall of 1976, Hi-Mill constructed a second smaller lagoon south of the original lagoon. This second lagoon received overflow waters from the original lagoon. Between 1981 and 1983 Hi-Mill attempted to evaporate the water remaining in the lagoons by intermittently discharging it through spray nozzles attached to the roof of the production building and to portions of the eight-foot high fence that surrounds the rear (south) of the Hi-Mill property.

In September 1983 Hi-Mill requested permission from the MDNR to remove the sludge from the larger lagoon, excavate surrounding soils, and backfill the area with clean fill. This was accomplished in November and December 1983 by General Oil Company of Livonia, Michigan. Contaminated soils were removed from the sides and bottom of the large lagoon, and then an additional one foot of clay was excavated from the bottom of the lagoon to ensure removal of all contaminated soils. Excavated sludges and soils were transported and properly disposed off-site by landfilling in a properly permitted facility. All activities were monitored by representatives of the MDNR, and the excavated site was inspected by the MDNR prior to backfilling. The excavation contractor has indicated that the smaller lagoon was not apparent during the excavation; the fate of this impoundment is not known.

Hi-Mill Manufacturing currently obtains process and drinking water from a water supply well located on the eastern edge of the east pavement area. This water supply well was installed in January 1989 by Layman Well Drilling and Repair. A six (6) inch diameter well screen was placed between 107' - 99'. Historically, water was drawn from two other supply wells that were located on the property . One former water supply well, lying immediately west of the production building, was set at 50' below grade, and the other former water supply well, lying immediately east of the production building was set at a depth of 89'. These wells were abandoned by Jim Layman of Layman Drilling in December 1989 as directed by the MDNR in order to prevent the potential downward migration of volatile organic compounds through the annular space. Abandonment was accomplishing by fracturing the well casings and then filling the entire cavity with grout under pressure.

Hi-Mill Manufacturing uses a septic system, located south of the main building, to dispose of sanitary sewage.

1.2.3 Previous Investigations

Seven contamination identification, assessment and/or control projects have been conducted at the Hi-Mill site to date. The activities and results of the projects are summarized below. Copies of reports discussed below (except for the November 1989 MDPH sampling of residential wells) are included in Appendix A of the Hi-Mill Manufacturing Company, RI/FS Work Plan, Revision 2, October 26, 1989.

Pre-1978 - MDNR Data

This report stated that a second lagoon was constructed in fall of 1976 and that direct overflows to the marsh occurred in December, 1976 and November, 1977. In April 1972 the MDNR staff investigated an employee complaint that the plant water wells might be contaminated. Samples of the groundwater from the two wells and surface water from the marsh were collected and analyzed. "Slightly elevated" (no comparison standard was presented) levels of copper (0.38 mg/l) were measured in one well, and elevated levels of copper and nitrates were measured in the marsh waters located immediately adjacent to the Hi-Mill property.

The MDNR collected additional samples of the marsh water on October 9, 1975. Analyses of these samples indicated elevated levels of copper, aluminum, zinc, chromium, and nitrates.

In May, November and December 1976, MDNR personnel collected and analyzed samples of the wastewaters contained in the two ponds. The mean concentrations of the parameters measured in these samples are presented below:

Parameter	Concentration (mg/l)
Copper	5.23
Aluminum	24.50
Chromium (total)	1.29
Chromium (hexavalent)	0.28
Nickel	0.02
pH	5.08
N (NH_3)	13.67
N (NO_2)	0.42
N (NO_3)	59.67

Based on available data, there is no indication whether or not the samples were filtered or that background or QA/QC samples were collected or analyzed to validate the data collected in any of these early studies.

November 1978 - MDNR Study of Adjoining Marsh Area

In April 1976, staff of the MDNR Water Quality Division undertook a study of the water and sediments in the marsh, water in the lagoon, and groundwater from one of Hi-Mill's water wells to assess contamination potential. The well selected for sampling was the one identified in the 1972 study as having elevated levels of copper. Background sediment samples were collected from Pontiac Lake.

The chemical analysis results indicated no metals contamination in the Hi-Mill water well sample. Elevated levels of nitrate, nitrite, ammonia, chromium, copper, zinc and aluminum were measured in water samples from the lagoon and marsh waters immediately adjacent to the Hi-Mill property. Since no background water samples were analyzed, it is not clear if results from a mid-marsh sample is reflect normal or elevated levels of chemical species measured. It is not known if the surface water samples were filtered to remove suspended sediment subsequent to collection.

Elevated levels of total chromium, copper and aluminum were measured in sediment samples collected from the lagoon and marsh. Slightly elevated levels of lead and zinc were also reported. No nickel contamination was reported.

August 1982 - MDNR Hydrogeological Study

In August 1982 the MDNR Water Quality Division performed a hydrogeological study at the Hi-Mill plant site. This study consisted of the installation of six, 1 1/4" PVC groundwater monitoring wells along the east and south property lines (adjacent to the Highland State Recreation Area), measurement of groundwater elevations, and sampling and analysis of groundwater samples. The monitoring wells were set at depths of 4' - 7' below grade in saturated surficial clayey soils of low permeability (MDNR conclusion based on soil type and well recharge time).

The flow of the perched water was determined to be generally in a southeasterly direction toward to marsh. Elevated levels (2 - 10 times background) of copper, chromium (total), zinc and aluminum were found in samples from monitoring wells located east and southeast of the lagoon. Concentrations of lead and nickel were found not to be above background levels. It is not known if the groundwater samples were filtered to remove suspended sediment subsequent to collection.

November 1983 - Removal of Lagoons

In September 1983 Hi-Mill requested permission from the MDNR to remove the sludge from the large lagoon, excavate surrounding soils, and backfill the area with clean fill. This was accomplished in November and December 1983 by General Oil Company of Livonia, Michigan. The contractor has stated that contaminated soils were removed from the sides and bottom of the lagoon, and then an additional one foot of clay was excavated from the bottom of the lagoon to ensure removal of all contaminated soils. Excavated sludges and soils were transported and properly disposed off-site in a licensed landfill. Manifests show that the following amounts of material were removed: 142 yards of contaminated soils, 34,400 gallons of contaminated sludge, and 63,300 gallons of water. All activities were monitored by representatives of the MDNR, and the excavated site was inspected by the MDNR prior to backfilling. The excavation contractor reported that the small lagoon observed in historical aerial photos was not in evidence at the time of excavation. The fate of the small lagoon is unknown.

April 1984 - MDNR Biological, Surface Water and Sediment Survey

In April 1984 personnel of the MDNR Surface Water Quality Division performed a limited biological, surface water and sediment survey of the marsh east of Hi-Mill, of Hi-Mill's roof and parking lot run-off areas and of the nearby Waterbury Lake. Water and sediment samples were collected and analyzed for aluminum, arsenic, iron, mercury, zinc, cadmium, chromium (total), copper, nickel and lead. Benthic and phytoplankton organisms were collected and identified visually on-site and by laboratory microscopy.

The chemical analyses of water samples indicated that concentrations of zinc, chromium and copper in marsh waters were lower than those measured in 1978, but still elevated in comparison to the background samples collected from Waterbury Lake. The levels of chromium and zinc did not exceed freshwater aquatic life criteria, but the levels of copper (50 - 200 μg/l) exceeded the chronic criteria (33 μg/l) for warm water fish. Elevated levels of copper, zinc, chromium and aluminum were also found in the run-off from the roof drainage and parking lot; the levels of copper in these samples exceeded the acute and chronic criteria for aquatic life. It is not known if the surface water samples were filtered to remove suspended sediment subsequent to collection.

Elevated levels (2 - 100 times those in sediments from Waterbury Lake) of aluminum, zinc, chromium (total), and copper were measured in sediments from the marsh and from parking lot and roof run-off drainage areas. Levels of arsenic, mercury, cadmium, nickel and lead were not found to be significantly different from the levels in Waterbury Lake samples.

The biological survey revealed few benthic or other bottom-dwelling organisms. Insufficient data were available to determine if this was a result of the significant marsh water level fluctuations or from metals contamination. Zooplankton were present at both sampling stations in the marsh. Daphnia sp., a copper sensitive organism, were abundant at the marsh sampling station where copper concentrations in the water were highest. The presence of a variety of filamentous green algae, flagellates, other algae and macrophytes indicated that the contamination did not have much impact on these aquatic plants.

The MDNR report concluded that 1) Waterbury Lake was not connected with the marsh east of Hi Mill Manufacturing and was not impacted by Hi Mill Manufacturing surface water discharges. 2) Marsh waters generally contained higher concentrations of heavy methods than the background stations in Waterbury Lake. 3) Concentrations of copper in marsh waters exceeded the chronic criteria for warm water species of fresh water aquatic life. 4) Sediment heavy metal concentrations in the marsh exceeded background concentrations in Waterbury Lake and in many cases mean concentrations in Waterbury Lake and in many cases mean concentrations downstream of industrial and municipal discharges. 5) Algar and 200 Plankton were abundant in marsh waters but bottom dwelling organisms were limited to pollution tolerant forms. The lack of additional species may be due to limited water in the dry season or the nutrient enriched condition of the marsh waters.

April - October 1987 - Numatics, Inc. Discharge Permit Data

Numatics, Inc. purchased the existing plant and property owned by the Highland Precision Company to manufacturer small stainless steel parts. Numatics, Inc. has been discharging wastewaters from metal finishing rinse tanks to a drain tile field under a MDNR groundwater discharge permit obtained in 1974. The permit established rinse water treatment criteria for nickel, chromium, nitrate, plus nitrite, and pH. In response to Numatics' most recent application to renew the discharge permit, the MDNR required a soils and groundwater assessment to determine if past discharge practices had negatively impacted the environment. The result of the soils investigation in the area of the drain field indicated that elevated levels of chromium and hexavalent chromium had accumulated in subsurface soils. Data from one round of samples from groundwater monitoring wells did not reveal significant levels of pollutants. No field or trip blanks were analyzed and no laboratory quality assurance data is available to assess the validity of results. The groundwater flow direction was determined to be southwest toward the wetland pond east and south of Hi-Mill. Depth to groundwater in the water table aquifer was approximately 17 feet below the surface. The area was identified as a recharge zone.

March - November 1988 - Oakland County Health Department Process Well Survey

The Oakland County Health Department and the Michigan State Department of Health sampled and analyzed water samples from Hi-Mill's two production water wells seven times during the period March 22, 1988 through November 2, 1988. Initially, samples were analyzed for water quality parameters, trace metals and volatile solvents; later analyses were confined to volatile solvents. All samples were analyzed by the Michigan Department of Health laboratories in Lansing, Michigan. No field or trip blanks were analyzed, and no laboratory quality assurance data is available to assess the validity of results.

All samples were found to contain "not detected" or acceptable levels of metals and other water quality parameters. The sample from March 1988 (composite of the two wells) was found to contain 41 μg/l trihalomethanes and 1 μg/l (method detection limit) benzene. No volatile organics were measured in a June 29, 1988 composite sample. On July 14, 1988, trichloroethylene was measured at 1 μg/l (method detection limit) in the west well, and benzene was measured at 4 μg/l in the east well. No organics were identified in a composite sample collected on September 1, 1988. Another set of samples was collected on October 4, 1988; trichloroethylene was measured in both the east and west wells (3 μg/l and 24 μg/l respectively), and cis-1,2-dichloroethylene was measured (2 μg/l) in the west well.

Analyses of samples collected on October 12, 1988 indicated the presence of trichloroethylene and cis-1,2-dichloroethylene in the west well at levels of 3 μg/l and 2 μg/l respectively. Trichloroethylene was measured in the east well at 12 μg/l.

A sample collected from the west well on November 11, 1988 was found to contain 7 μg/l trichloroethylene and 2 μg/l cis-1,2-dichloroethylene. The sample from the east well was found to contain 3 μg/l trichloroethylene.

The Michigan Department of Health notified Hi-Mill on November 7, 1988 that the analysis results indicated that the water from the process wells was not acceptable for human consumption. Hi-Mill was instructed to warn employees not to drink the water, to provide bottled drinking water, abandon both existing wells, and to install a new well to provide potable water to the facility.

November 1988 - Techna Corporation Hydrogeological Study

Techna performed a limited hydrogeological assessment of the Hi-Mill site in November 1988 in response to the findings of chlorinated solvents in the Hi-Mill process wells.

The hydrogeological assessment accomplished the following objectives: 1) determine subsurface stratigraphy to a depth of approximately 100'; 2) sample and analyze groundwater samples to determine extent of possible solvent contamination; 3) determine approximate direction of groundwater flow in the deeper aquifer(s); 4) evaluate connectivity between multiple, deeper saturated zones if any were found; and 5) evaluate the potential for contaminants in surficial saturated zones near the process wells.

Three boreholes were advanced at the Hi-Mill site to an approximate depth of 100' below the existing ground surface. Boreholes were placed at the northeast corner of the property, at the west corner of the property, and south of the production building in the area of the former lagoon. Soil types were logged during the drilling operations, and temporary, 2" diameter PVC monitoring wells were placed in each location.

The general subsurface stratigraphy at the site consists of 1.5' - 3' of fill underlain by 26' - 45' of stiff, moist, silty blue clay. This layer was contiguous in the northeast and south borings; however, in the west boring a layer (5' ± 2') of fine silty sand was found in the clay stratum between the depths of 12' and 17', and a compact sandy silt layer (3' ± 1') was found between the depths of 24' and 27'.

In the northeast borehole, a wet sand stratum was encountered between the depths of 45' and 63'. This was underlain by a 21.5' thick layer of extremely stiff blue clay, which was in turn underlain by a wet layer of sand and gravel extending from 91' below ground level (BGL) to the terminus of the boring at 105.6'.

In the west borehole, the clay layer was underlain by various wet sand strata to a depth of 113' BGL, the terminus of the boring. The underlying sand strata were interspersed with layers of blue clay (64.5 - 66.5' BGL and 96.5 - 101' BGL) and extremely compact sand and silt (76' - 92' BGL).

The south boring initially encountered approximately 8' of sand fill in the are of the former lagoon. This was underlain by the same clay stratum (26' thick) found in the other borings. The upper clay layer was underlain sequentially by compact to extremely compact wet sand (34' - 49.5' BGL), extremely stiff blue clay (49.5' - 59' BGL), wet gray sand (59' - 65.5' BGL), extremely stiff blue clay (65.5' - 87' BGL) and wet sand and gravel (87' - 100' BGL) to the end of the boring.

Temporary groundwater monitoring wells were then set in separate boreholes at the 1) Northeast property corner - one screen was set at 55' BGL in the uppermost saturated zone, and one was set at 105' in the lower saturated zone; 2) West property corner - one well was set at 56' BGL in the uppermost significant saturated zone; and 3) South of production building - one well was set at 50' BGL in the uppermost saturated zone , and one well was set at 93' BGL in the lower saturated zone. The wells were fitted with 5' screens, and the bottom of the screens were placed at the depths listed above. After installation, the wells were developed and allowed to reach equilibrium.

Groundwater elevation measurements revealed that the static water levels in all wells were the same within an absolute variance interval of ± 0.6' about the mean elevation. The groundwater was determined to be flowing in a generally southeast direction.

Groundwater samples were collected from each temporary monitoring well and analyzed for the Priority Pollutant volatile organic species. No contaminants were found in any of the samples.

Soil samples were collected in the surficial fill materials (found to be dry or slightly moist) near each process well and analyzed for the presence of chlorinated solvents. One sample was collected approximately 8' - 10' north of the east well, and one sample was collected approximately 8' - 10' southwest of the west well. No chlorinated solvents were found in either sample.

MDPH November 1989 Public Supply Well Sampling

The Michigan Department of Public Health (MDPH) sampled seven residential wells along the west side of Waterbury Road in early November 1989. These wells are the closest known residential wells to the Hi-Mill site. Groundwater from these wells was analyzed for metals and some volatile organic compounds. No volatile organic compounds were detected and metals were all below established drinking water guidelines. The MDPH concluded that these samples indicate that there is no contamination in the seven wells tested.

<u>October 26, 1989 Hi-Mill Manufacturing Company Remedial Investigation/Feasibility Study Work Plan/Site Safety Plan /QAPP</u>

The Remedial Investigation was performed in accordance with the Hi-Mill Manufacturing Company Remedial Investigation/Feasibility Study Work Plan, Site Safety Plan and QAPP which were submitted to the U.S. EPA as Revision 2 on October 26, 1989 and subsequently amended and approved in January 1990.

Remedial Investigation activities were funded by Hi-Mill Manufacturing Company as agreed under Administrative Order of Consent, U.S. EPA Docket Number V-W-88-C-127. Field activities were performed by Techna Corporation and their subcontractors as presented in the Remedial Investigation Work Plan. Field activity oversight was provided by the U.S. EPA, contractors to the U.S. EPA and the Michigan Department of Natural Resources.

1.3 Report Organization

This report has been divided into seven sections in accordance with the recommendations of the U.S. EPA guidance presented in "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA". Contents of the remaining six sections are summarized below.

Section 2.0 describes and documents the various types of investigations that were performed during the Remedial Investigation. These various investigation categories are surface features, contaminant sources, surface waters and sediments, soils, and groundwater. Section 2.0 also presents a brief summary of the June 1, 1990 "Phase I Data Completeness Technical Memorandum".

Section 3.0 describes the physical characteristics of the site as developed from information collected during the Remedial Investigation. Physical characteristics of surface features, surface water, geology, soils and hydrogeology are described.

Section 4.0 presents and assessment of the nature and extent of contamination in soils, groundwater, surface water and sediments based upon the Remedial Investigation data. Summaries of all analytical results are presented in this section.

Section 5.0 discusses the fate and transport of significant contaminants identified in Section 4.0. Potential routes of migration and persistence of the contaminants are discussed.

Section 6.0 presents the baseline risk assessment. This section identifies the harm that the contaminants could cause if no remedial action is taken. This section analyses potential human exposure, toxicity to humans, the risk to human health and potential adverse effects on the environment.

Section 7.0 presents a summary of the nature and extent of contamination, fate and transport of the contaminants and the assessment of risk. Conclusions related to data limitations, recommendations for future work and recommended remedial action objectives are also presented.

2.0 STUDY AREA INVESTIGATION

Remedial Investigation field activities are described in Section 2.1. A brief summary of the June 1, 1990 Data Completeness Evaluation Technical Memorandum is presented in Section 2.2.

2.1 Field Activities

Investigation of the study area was performed by Techna Corporation between November 6, 1989 and May 11, 1990. Field oversight was provided by U.S. EPA contractor GZA/Donahue and their subcontractor Soil Testing Services, Inc. The Michigan Department of Natural Resources performed a limited field oversight role.

Field activities are summarized in the following subsections: Subsection 2.1.1, Surface Features; Subsection 2.1.2, Surface Water and Sediment Investigations; Subsection 2.1.3, Soil Investigations/Chemical Characteristics; Subsection 2.1.4, Soil Investigations/Physical Characteristics; Subsection 2.1.5, Groundwater Investigation/Chemical Characteristics; and Subsection 2.1.6, Groundwater Investigation/Physical Characteristics.

2.1.1 Surface Features

Surface features at the Hi-Mill site are of both man-made and natural origin. Abrahms Aerial Survey Corporation performed an aerial survey of the site in May 1989. The photographic survey resulted in a topographic map of the study area with a scale of one inch equals fifty feet and a contour interval of two feet. This survey located site boundaries, fences, roads, drainage ditches, tile fields, wetlands, lakes, buildings and vegetated areas. This topographic, site feature map reduced to approximately one inch equals one hundred feet, is presented as Plate I in the map pocket of this report.

Site features and utilities near the Hi-Mill facility were surveyed by Ayers, Lewis, Norris, and May Inc. along with actual boring and well locations and well elevations. Site features and utilities are shown schematically on Figure 1-2.

Historic aerial photographs from May 3, 1949, May 7, 1956, May 23, 1961, April 25, 1967 and spring of 1965, 1974, 1980 and 1985 have been examined. Plates II and III are prints from aerial photographs obtained through Oakland County. These photos document the site features as they appeared in 1985 and 1980. Property boundaries are shown on the 1985 photo. The 1980 photo shows the location of two wastewater lagoons south of the Hi-Mill building, the Target Wetland at a relatively low water level, State Road M-59 prior to widening and several structures that are no longer present.

Two wastewater lagoons referenced in previous reports related to the Hi-Mill site are shown on the 1980 photo. These lagoons are no longer present but their former locations were the target for soil sample locations that are discussed in Section 2.4 of this report.

The 1980 photograph shows that directly to the west of Hi-Mill is a small structure that at one time was part of a small private airport, directly across M-59 from the Hi-Mill facility are two residences and a building that was at one time a gas station. These buildings were removed during the period when M-59 was expanded to a four-lane, divided highway in the early 1980s.

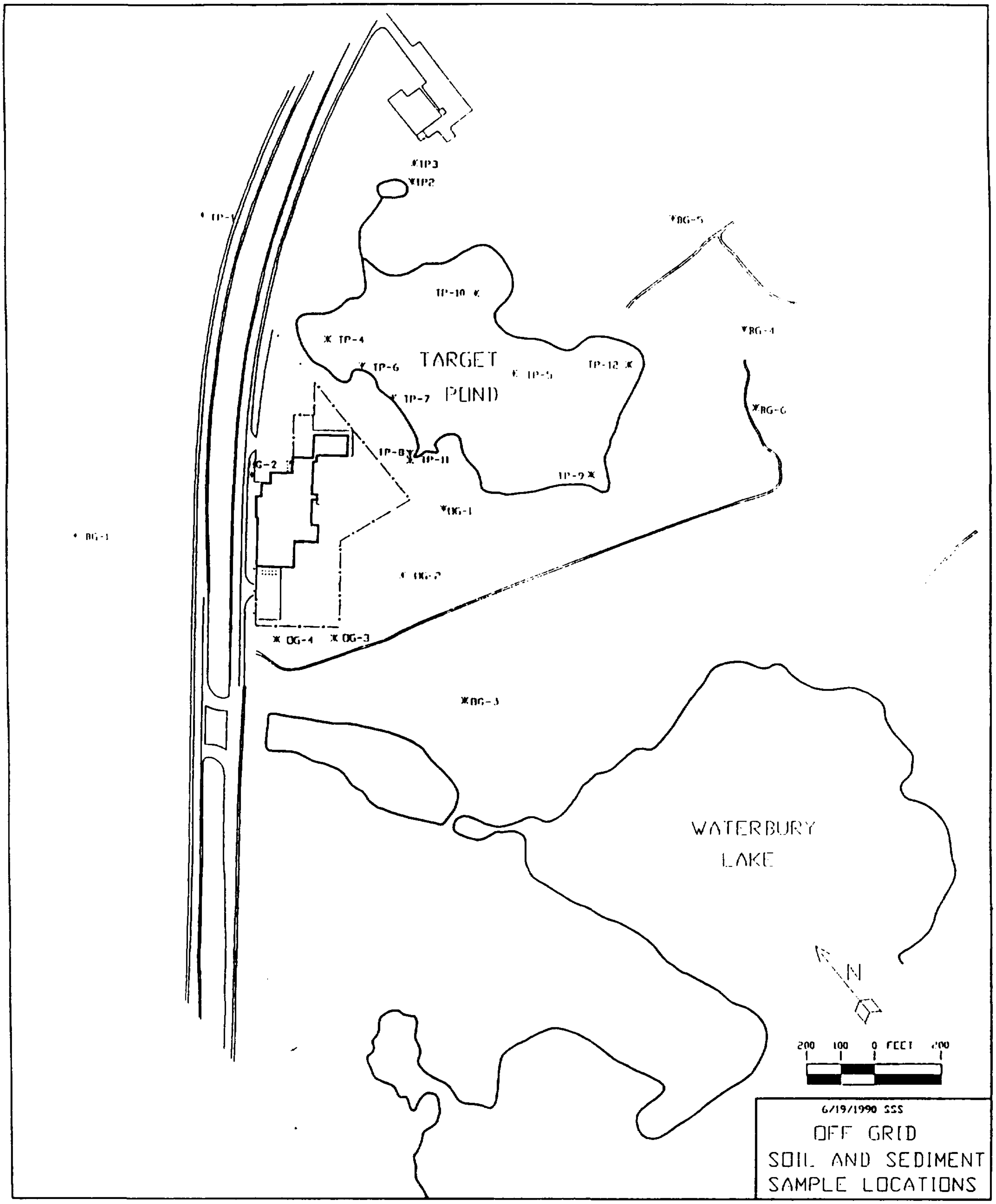
2.1.2 Surface-Water and Sediment Investigations

Purpose and Scope

Samples of surface waters and sediments from the Target Wetland, Waterbury Lake and the Background Pond were collected from the locations shown in Figure 2-1. All samples were analyzed for copper, chromium, aluminum, silver, nickel and zinc to evaluate the levels and distribution of contaminants. Three sediment and water samples at locations shown on Figure 2-1 were analyzed for the TAL inorganic parameters to ensure that other contaminants are not present in the wetland area.

Sediment samples were collected from ten stations in the wetland, two stations in Waterbury Lake and one station north of M-59. Surface water samples were collected from all thirteen stations. Background samples were collected from a background wetland, of the same classification (Soil Conservation Service) as the marsh, located approximately 1000' southwest of Waterbury Lake. Four water and four sediment samples were collected from evenly distributed locations in the background wetland.

Figure 2-1. Background Soil, Off-Grid Soil, Surface Water and Sediment Sample Point Map



The Remedial Investigation resulted in the collection and analysis of the following surface water samples: 12 samples for short list metals, including 1 field duplicate and 1 field blank; 5 samples for TAL inorganics, including 1 field duplicate and 1 field blank; 17 samples for hexavalentchromium, including 2 field duplicates and 2 field blanks; 9 samples for ammonia and nitrate/nitrite, including 1 field duplicates and 1 field blanks.

The Remedial Investigation resulted in the collection and analysis of the following sediment samples: 22 samples for short list metals, including 3 field duplicates; 5 samples for TAL inorganics, including 1 field duplicate; and 25 samples for hexavalent chromium, including 3 field duplicates.

Master data tables for surface water and sediment samples are presented as Appendices A and B respectively. The surface water and sediment master data tables present station, sample ID, ENCOTEC sample number, sample collection date, project east location coordinate, project north location coordinate, elevation and sample type for each surface water sample point.

Methodology

All sampling and testing procedures conformed to either approved Remedial Investigation protocols or subsequently approved (U.S. EPA RPM) field modification. Surface water and sediment samples were collected from separate holes cut through approximately three to eight inches of ice which covered the lakes and wetlands. Before sample collection, pieces of ice were removed from the ice hole. One sediment sample (TP-12) was collected in the target pond by wading into the lake.

Sediment samples were collected using split spoon samplers pushed or driven into the upper one and one half feet of sediment. Sediment samples were extruded into a plastic collection bowl and homogenized with stainless steel sample scoops before being placed in 8 ounce plastic containers for analysis. Split spoon samplers, sample scoops and plastic bowls were decontaminated using a detergent (Liquinox) and tap water wash, tap water rinse, 10% nitric acid rinse and distilled water rinse sequence and then air dried. The split spoon ends were wrapped in plastic before being sealed in aluminum foil for field transport. The sample scoops and plastic bowls were wrapped in plastic for field transport.

Surface water samples were collected from approximately six inches below the water surface at each location. Each collection bottle was initially rinsed with surface water before sample collection;

collection bottles were used at only one location. The dedicated collection bottle was used to transport the water sample for metal analyses back to the site trailer for filtering.

Sample filtering was performed by pouring the sample directly into a Geotech barrel filter and forcing the sample under pressure through a 0.45 micron disposable filter directly to laboratory prepared sample bottles. The barrel filter was decontaminated prior to each use by a detergent (Liquinox) and tap water wash, tap water rinse, 10% nitric acid rinse and distilled water rinse sequence. A new 0.45 micron filter was used for each sample collected.

QA/QC samples consisted of field duplicates, field blanks and trip blanks. Trip blanks were prepared by ENCOTEC using organic-free deionized water, and were used at a rate of one per shipment cooler. Duplicate surface water and sediment samples were collected in a second set of bottles at a rate of one per ten samples collected for each analyses parameter. Field blanks for metal analyses were prepared by pouring distilled water into a dedicated laboratory prepared sample collection bottle which was rinsed prior to sample collection with 10% nitric acid and distilled water, then directly into a decontaminated Geotech barrel filter and forced under pressure through a 0.45 micron disposable filter directly to laboratory prepared sample bottles. Field blanks for organic analyses were prepared by pouring organic-free deionized water into a dedicated laboratory prepared sample collection bottle, then into a laboratory prepared sample bottle. Field blanks for volatile analyses were prepared by pouring distilled water into a dedicated laboratory prepared sample collection bottle, then into a laboratory prepared sample bottle.

All sample bottles were properly labeled and placed on ice while on site. Accurate records were kept of all sampling activities. At the end of each day's sample collection activities, samples were transported in coolers by Techna personnel to ENCOTEC in Ann Arbor, Michigan. Samples for inorganic analyses were subsequently shipped to Wilson Laboratories in Salina, Kansas by ENCOTEC for analyses. Proper chain-of-custody procedures were strictly followed.

2.1.3 Soil Investigations/Chemical Characteristics

Purpose and Scope

Soil sampling was performed in five separate suspect areas. The five areas were 1) a sample grid to evaluate potential metals contamination on unsurfaced areas generally south of the Hi-Mill buildings, 2) a sample grid to evaluate potential organic contamination near the abandoned northeastern water supply well, 3) a sample grid to evaluate potential organic contamination around the abandoned southeastern water supply well, 4) off-grid sample points targeted at potential locations of surface run-off south and west or the property fence, and 5) off-grid sample points targeted for the location of the former large lagoon, the former small lagoon and the existing raised leach field. Soil samples were collected from locations shown on Figure 2-2 and Figure 2-3.

Eight background soil samples were collected from six different locations north, west and southeast of the Hi-Mill site. Background soil sample locations are shown on Figure 2-1.

Sample Area 1 is within the unsurfaced area generally south of the Hi-Mill buildings suspected for metals contamination. Samples from Area 1 have sample notations designated with alpha-numeric identifiers A through M and 1 through 8, e.g. E3.

Sample Area 2 is within a 20 by 40 foot grid adjacent to and northeast of the Hi-Mill office suspected of volatile organic contamination. Samples from Area 2 have sample notations of either VW, WX, XY,or YZ and 01 or 12, e.g. WX12.

Sample Area 3 is within a 20 by 40 foot grid adjacent to and southwest of the Hi-Mill building suspected of volatile organic contamination. Samples from Area 3 have sample notations of either RS or ST and 01, 12, 23, or 34, e.g. RS23.

Sample Area 4, consisted of small eroded drainage channels southwest of the site suspected as potential migratory pathways for metals contamination. Samples from Area 2 are designated with the sample notation OG.

Sample Area 5, consisted of borings G3/H4, G4 and H4/I4/I5 targeted for the suspected area of the former location of the small lagoon; borings H3/I4, I4 and I3 targeted for the former location of the large lagoon; and borings G4 and G4/H5 targeted for the currently operating raised seepage bed. Modifications to the originally planned locations were made after approval by the U.S EPA, the U.S EPA oversight contractor and the MDNR.

Background soil samples were collected in areas that were suspected to be free of contaminants. Background soil samples are designated with the sample notation BG.

Figure 2-2. TAL Inorganics and Short List Metal Soil Sample Point Map

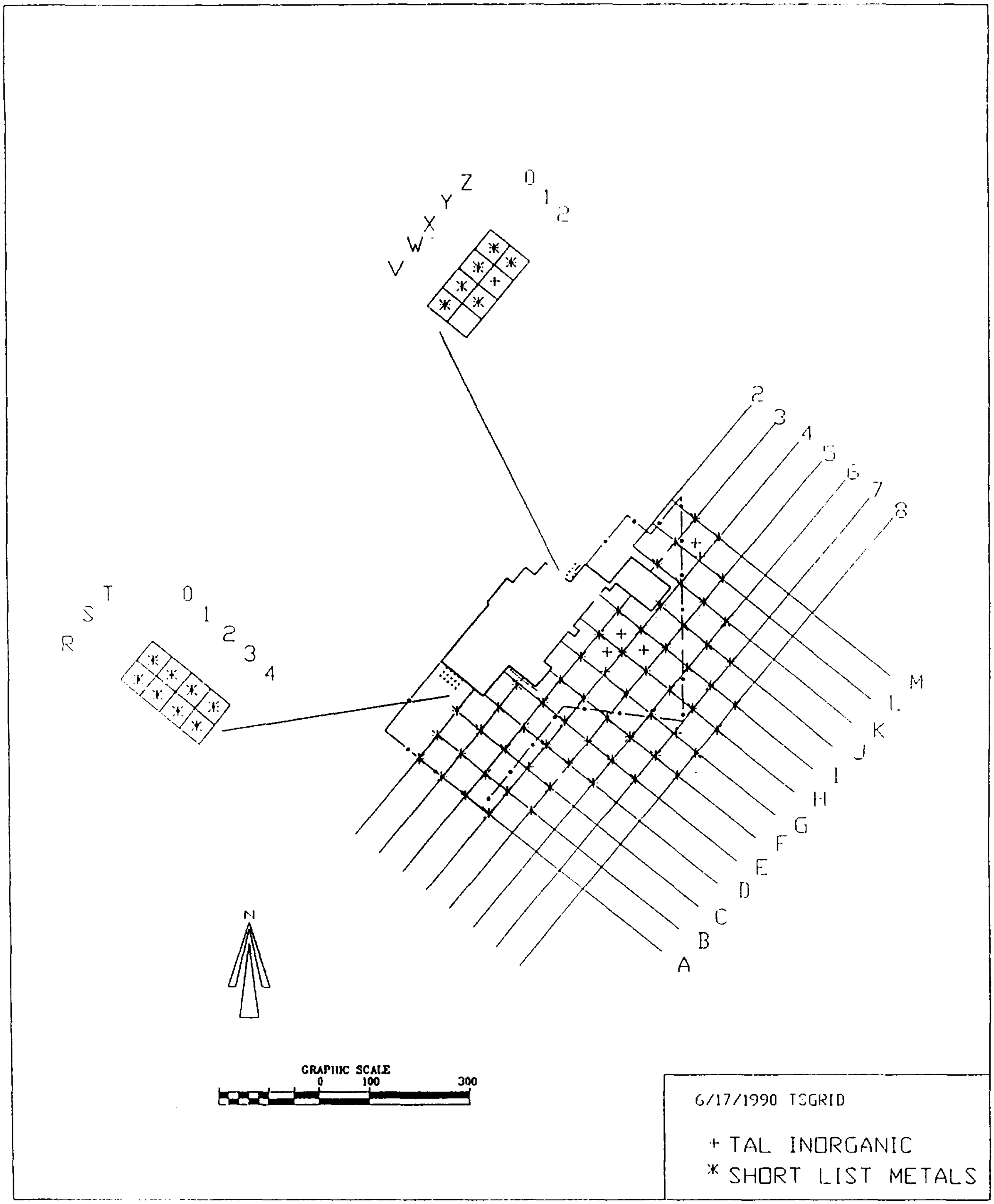
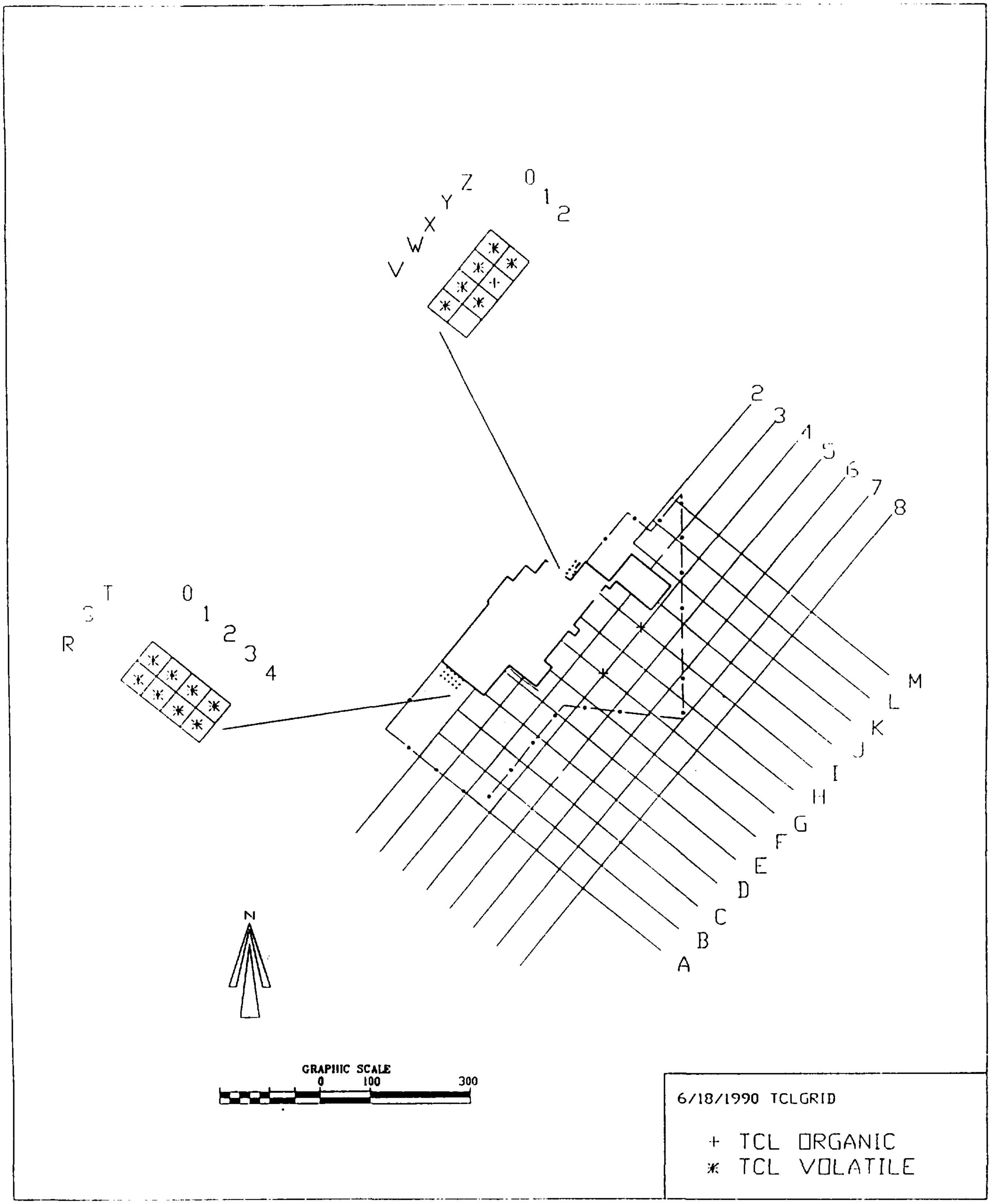


Figure 2-3. TCL Volatile Organic and TCL Organic Soil Sample Point Map



The Remedial Investigation resulted in the collection and analysis of the following soil samples: 176 samples for short list metals, including 15 field duplicates; 26 samples for TAL inorganics, including 2 field duplicates; 54 samples for TCL volatiles, including 5 field duplicates; and 15 samples for TCL other organics, including 2 duplicates.

A master data table for soil samples is presented as Appendix C. The soils master data table presents the sample ID, ENCOTEC laboratory ID number, boring type, sample collection date, project east location coordinate, project north location coordinate, elevation, sample depth category, and sample type category for each soil sample.

Methodology

All sampling and testing procedures conformed to either approved Remedial Investigation protocols or subsequently approved (U.S. EPA RPM) field modification. Surface soil samples from area 1, area 4 and background locations were collected using a stainless steel hand auger. Area 1 surface soil samples, collected below water level, within the wetlands between the target pond and the Hi-Mill site, were collected using two-inch (2") diameter, eighteen-inch (18") split spoon samplers attached to an AW rod and forced by a portable drop hammer into the soil for a depth of eighteen inches (18"). Soil samples from soil borings (areas 1, 2, and 3) were drilled with hollow stem augers and were collected using two-inch (2") diameter, eighteen (18") or twenty-four (24") inch long split spoon samplers. Hollow-stem auger drilling procedures were followed as described in Section 2.5 of this report.

The soil profile was logged noting such features as color, grain size, sorting, roundness, structure, composition, and obvious presence of contamination such as discoloration and odor. Representative aliquots of selected split spoon samples were collected and were retained for visual records.

All boreholes, where monitor wells were not installed, were backfilled with bentonite grout upon completion. Decontamination procedures for drilling equipment were followed as described in the Section 2.5 of this report.

Soil samples collected for TCL non-volatile organic and TAL inorganic analyses were extruded into stainless steel and plastic bowls, respectively and homogenized with a stainless steel scoop before being placed in sample containers. Samples collected for TCL volatile organics were placed directly into sample containers. A duplicate sample was obtained for every ten (10) samples collected for each analyte. The split spoon samplers, hand augers, bowls and scoops were decontaminated using a detergent (Liquinox) and tap water wash, steam cleaning or tap water rinse, 10% nitric acid rinse and distilled water rinse sequence. A further rinse sequence of methanol and final distilled water was used when collecting for TCL organic analyses. The split spoons, bowls and scoops were air dried. For samples collected for TAL inorganic analyses the split spoon ends, plastic bowls and scoops were wrapped in plastic, with a final wrap of aluminum foil on the split spoons, for field transport. For samples collected for TCL organic analyses the split spoons, stainless steel bowls and scoops were wrapped in aluminum foil for field transport.

All sample containers were properly labeled and placed on ice at the site. Accurate written records were kept of all sampling activities. At the end of each day's sample collection activities, samples were transported in coolers by Techna personnel to ENCOTEC in Ann Arbor, Michigan. Samples for TAL inorganic analyses were subsequently shipped to Wilson Laboratories in Salina, Kansas by ENCOTEC for analyses. Approved chain-of-custody procedures were strictly followed.

Modified Level D protection, as defined in the approved Health And Safety Plan, was used during drilling and sampling operations. A photoionization detector was used for ambient air monitoring of volatile organics during drilling operations. A combustible gas indicator was used for continuous ambient air monitoring of combustible gases during drilling operations. No ambient air conditions requiring modification of personal protection were encountered.

2.1.4 Soils Investigation/Physical Characteristics

Purpose and Scope

Physical characteristics of selected soils were tested to establish the types of site soils and the range of physical characteristics for each type. The following soil characteristic tests were performed as part of the Remedial Investigation: 16 samples for grain-size, including 1 field duplicate; 8 samples for Atterberg limits; 11 samples for moisture contents, including 1 field duplicate; and 15 samples for vertical hydraulic conductivity, including 1 field duplicate.

Methodology

All soil boring and monitor well installation procedures conformed to either approved Remedial Investigation protocols or subsequently approved (U.S. EPA RPM) field modification. Drilling of boreholes for well installation was performed by McDowell and Associates using four and one-quarter inch (4-1/4") I.D. hollow stem augers.

Soil samples were obtained approximately every five feet (5') or at changes in soil type using eighteen (18") or twenty four (24") inch long split spoon samplers in advance of the hollow stem augers according with ASTM Method D-1586. As split spoons were driven, blow counts were recorded every six inches (6"). Shelby tube and brass lined split spoons were used to collect soil samples for physical property analysis. At nested well locations, separate boreholes were drilled for shallow, intermediate and deep wells, however soil sampling and logging was only conducted as deeper depths were progressively drilled.

Each well was constructed of two-inch (2") diameter flush-coupled PVC casing with a three-foot (3') or five-foot (5') length, No. 10 slot, stainless steel or PVC screen and fitted with a like plug and vented PVC cap. All wells extended at least one foot (1') above the ground surface and were protected with a locking steel casing which was secured with keyed-alike padlocks. To prevent possible downward migration of shallow groundwater, intermediate and deep wells were set within a ten inch (10") diameter PVC outer casing which was grouted in place and allowed to set before deeper drilling occurred.

Decontamination procedures for well installation conformed to either approved Remedial Investigation protocols or subsequently approved (U.S. EPA RPM) field modification. All well casings, screens, caps, plugs and split spoon samplers were scrubbed with a detergent (Liquinox) and tap water wash followed by a steam cleaning/rinse. The drilling equipment (i.e. augers, rods, bits, etc.) were steam cleaned prior to the onset of drilling activities and between boring locations. Steam cleaning was conducted in a designated area in the Hi-Mill parking lot. Upon completion of drilling activities, all drilling equipment was steam cleaned.

Monitor well installation was accomplished as follows. The well screen and capped casing was lowered through the hollow stem augers to the selected depth followed by; 1) the emplacement of a sand pack to a height of approximately two feet (2') above the top of the screen while simultaneously retracting the augers, thus allowing the sand to settle into the annular space between the well screen and borehole wall; 2) with the auger bottom located approximately at the top of the sand pack, installation of approximately two feet (2') bentonite pellet seal; and 3) the remaining annular space was grouted from the bottom up with a bentonite-portland cement slurry. A steel protective casing was installed around the well casing and extended approximately three feet (3') into the cement slurry below ground surface. Due to the shallowness of SW-5, SW-9A and SW-20, a steel plate with a six inch center hole was welded to the base of the steel casing such that shallower cementing of the protective casing was achieved and allowing the maximum length of screen to access the aquifer. SW-5, SW-9A and SW-20 had less than the two feet (2') of sand pack and bentonite pellets above the screen. SW-9A was installed in a hand augured boring. A notch was cut in the top of all well casings at the lowest point to serve as a measuring point. Each protective casing was labeled with the well number. Details for the construction o: ndividual wells are presented in Appendix F.

Wells were developed at least twenty-four hours after well installation. The shallow wells were developed with a stainless steel bailer, except for SW-5, SW-7, SW-14, SW-15 and SW-22 which have PVC screens and were bailed with a PVC bailer. Prior to development, static groundwater levels were recorded and subtracted from previously obtained bottom of screen measurements to estimate the casing volume in each well. Bailers were decontaminated with a steam cleaning rinse, 10% nitric acid rinse and distilled water rinse sequence between well locations. The stainless steel bailers had an additional methanol and final distilled water rinse. The static water level indicator was decontaminated before and after use with a 10% nitric acid rinse, distilled water rinse, methanol rinse and final distilled water rinse sequence. Each bailer was fitted with a new piece of teflon-coated wire or nylon string prior to placement in the well. The shallow wells were initially surged with the bailer for approximately three to five minutes before groundwater was removed. Except for wells that were bailed dry, approximately five (5) well volumes were purged from each shallow well. Wells bailed dry were allowed to recharge, were and were rebailed to dryness.

The intermediate and deep wells were developed using filtered compressed air forced into the well at screen depth through one-inch (1") PVC pipe coupled with threaded connections. The PVC pipe was steam cleaned before being lowered into each well. Approximately five (5) well volumes were purged from these wells using this method, except for DW-2. Further development of DW-2, which initially produced very little water, was accomplished by purging with a stainless steel bailer and using the ›oguard bladder pump system.

Modified Level D protection as approved in the Health and Safety Plan was used during drilling and sampling operations. A photoionization detector was used for ambient air monitoring of volatile organics during drilling operations. A combustible gas indicator was used for continuous ambient air monitoring of combustible gases during drilling and monitor well installation. No ambient air conditions requiring modification of personal protection were encountered.

2.1.5 Groundwater Investigation/Chemical Characteristics

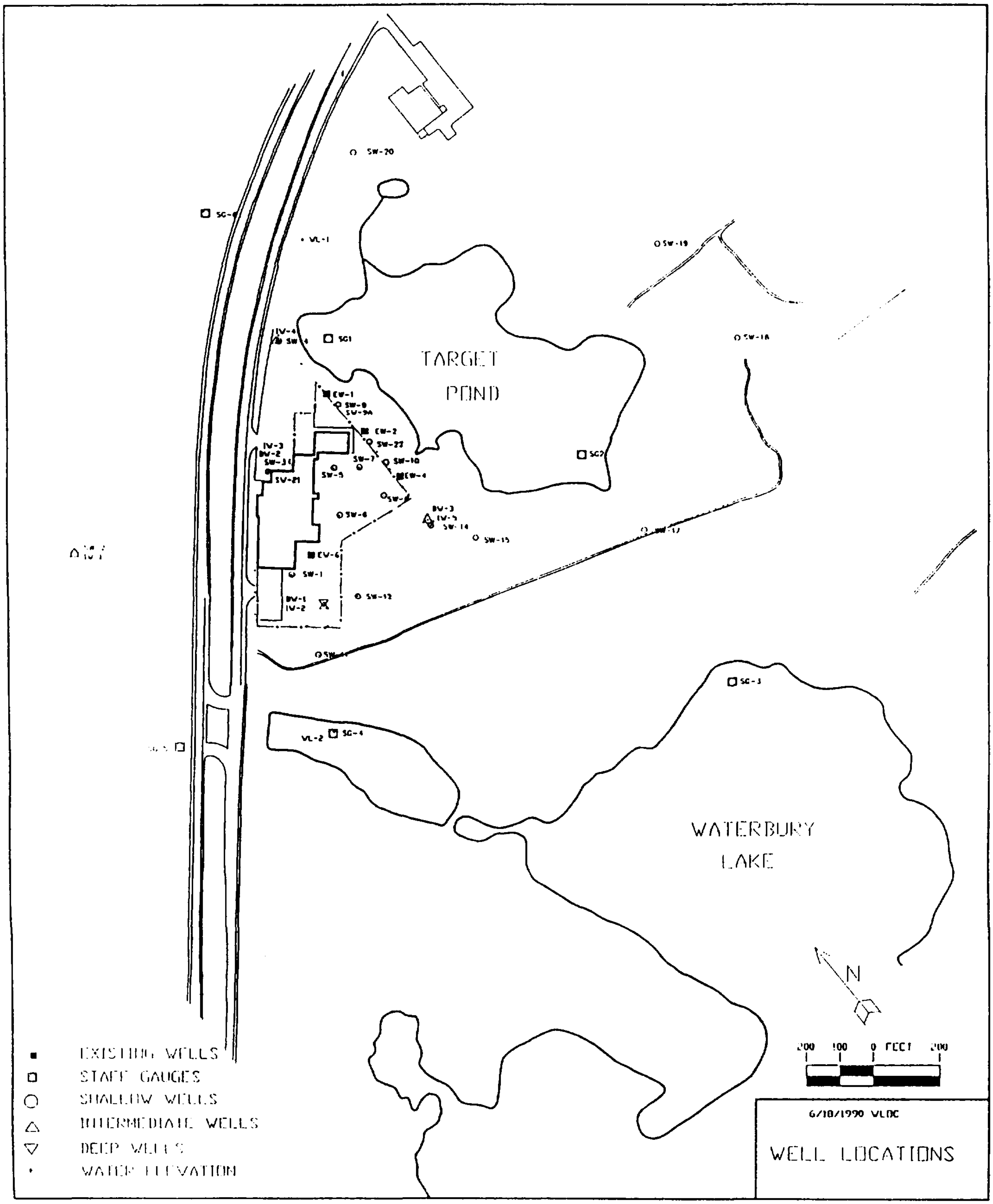
Purpose and Scope

The hydrogeological study was comprised of several components designed to attain the following objectives: determine groundwater flow direction and define and characterize the contaminant plume in surficial groundwater south and east of the site; determine the potential for migration of contaminants in surficial groundwater beyond the southern and eastern boundaries of the marsh; confirm groundwater flow direction and the potential for contamination of the two deeper aquifers located at approximately 50' and 85' below ground level; investigate the hypothesis that trichloroethylene contamination in the process wells is localized and not part of a larger contaminant plume; and determine the potential for contamination of the two deeper aquifers.

The Remedial Investigation resulted in the installation of twenty-one (21) shallow wells, five (5) intermediate wells, and three (3) deep wells (Figure 2-4). Borings SW-13 and SW-16 did not have shallow wells installed as planned due to the absence of shallow saturated zones. SW-9A and SW-22 were installed, although not planned in the Remedial Investigation Work Plan. SW-9A was installed to replace SW-9, which the MDNR thought was screened too deep. SW-9 has been used only for static water level measurements. SW-22 was installed to provide a supplemental monitoring point.

The Remedial Investigation resulted in the collection and analysis of the following groundwater samples: 31 samples for short list metals, including 3 field duplicates and 3 field blanks; 8 samples for TAL inorganics, including 1 field duplicate and 1 field blank; 29 samples for TCL volatiles, including 3 field duplicates, 3 field blanks and 3 matrix spikes; 5 samples for TCL other organics, including 1 field duplicate and 1 field blank; 30 samples for ammonia and nitrate/nitrite, including 3 field duplicates and 3 field blanks; and 32 samples for pH, and 33 samples for temperature and conductivity.

Figure 2-4. Monitor Well, Staff Gauge Location Map



A groundwater master data table is presented as Appendix D. The groundwater master data table presents sample ID, ENCOTEC laboratory ID number, descriptions of aquifer type, bottom of screen depth, sample collection date, east location coordinate, north location coordinate, top of screen elevation and sample type.

Methodology

All sampling and testing procedures conformed to either approved Remedial Investigation protocols or subsequently approved (U.S. EPA RPM) field modifications. Sampling of a well occurred no sooner than fourteen days following the development of that well.

Prior to sampling, static groundwater levels were recorded and subtracted from previously obtained bottom of screen measurements to calculate the volume of standing water in each well. The measuring tape and water level indicator was decontaminated before and after use using a detergent (Liquinox) and tap water wash, tap water rinse, 10% nitric acid rinse, distilled water rinse, methanol rinse and final distilled water rinse sequence.

Three to five well volumes were removed from each intermediate well (IW), each deep well (DW), and shallow wells SW-5, SW-17, SW-20 and EW-4, just prior to sampling. Due to slow recharge, all other shallow wells (SW and EW) were bailed dry, then allowed to recharge prior to sampling. The deep and intermediate wells were purged and sampled using a gas driven, air lift bladder pump Geoguard system. The bladder (teflon) pump (stainless steel) system ensured that lift air did not come in contact with the groundwater sample during pumping action. Two, three-foot bailers and one, eighteen-inch stainless steel bottom loading bailers with teflon check valves were dedicated to the Hi-Mill site and used to purge and sample the shallow wells.

The bladder pump and bailers were decontaminated between wells using a steam cleaning wash, detergent (Liquinox) and tap water wash, tap water rinse, 10% nitric acid rinse, distilled water rinse, methanol rinse and final distilled water rinse sequence. The air lift sampling hose for the Geoguard system was steam cleaned and then assembled to the decontaminated bladder pump and the entire system flushed with distilled water and organic-free deionized water sequence. Additional flushing of the system occurred during purging of the wells prior to sampling. Each bailer was fitted with a new piece of teflon-coated wire prior to placement in the well.

Samples for analysis of organic parameters were poured directly from the bailer or collected directly upon discharge from the Geoguard sampling hose into the sample bottles. VOA vials were completely filled to ensure that no headspace remained after capping. Samples for metal analysis were poured directly from the bailer or collected directly upon discharge from the Geoguard sampling hose into sample collection bottles dedicated to each well. The sample was then transported directly to the site trailer for filtering. Samples were filtered under pressure through a 0.45 micron disposable filter using a Geotech barrel filter.

The barrel filter was decontaminated prior to and after use by a detergent (Liquinox) and tap water wash, tap water rinse, 10% nitric acid rinse and distilled water rinse sequence. The dedicated laboratory prepared sample collection bottle was rinsed prior to sample collection with 10% nitric acid and distilled water. A new 0.45 micron filter was used for each sample collected.

QA/QC samples consisted of field duplicates, field blanks and trip blanks. Trip blanks were prepared by ENCOTEC using organic-free deionized water for each shipment cooler. Duplicate groundwater samples were collected in a second set of bottles at a rate of one per ten samples collected for each analyses parameter. Field blanks for metal analyses were prepared by pouring distilled water into a decontaminated bailer, then into a laboratory prepared sample collection bottle which was rinsed prior to sample collection with 10% nitric acid and distilled water, then directly into a decontaminated Geotech barrel filter and forced under pressure through a 0.45 micron disposable filter directly to laboratory prepared sample bottles. Field blanks for organic analyses were prepared by pouring organic-free deionized water into a decontaminated bailer, then into a laboratory prepared sample bottle. Field blanks for volatile analyses were prepared by pouring distilled water into a decontaminated bailer, then into a laboratory prepared sample bottle.

All sample bottles were properly labeled and placed on ice while on site. Accurate records were kept of all sampling activities. At the end of each day's sample collection activities, samples were transported in coolers by Techna personnel to ENCOTEC in Ann Arbor, Michigan. Samples for inorganic analyses were subsequently shipped to Wilson Laboratories in Salina, Kansas by ENCOTEC for analyses. Proper chain-of-custody procedures were strictly followed.

The temperature of each groundwater sample was measured immediately upon sample collection. The pH and specific conductivity of most groundwater samples was measured immediately upon sample collection; however, measurements on samples collected from wells SW-9A, SW-22, EW-1, EW-2, EW-6, IW-2, IW-5, DW-1 and DW-3 were performed at Brighton Analytical within twenty minutes from time of collection. Instrument probes used to measure pH, specific conductivity and temperature were calibrated daily in accordance with the QAPP and used according to manufacturers directions.

2.1.6 Groundwater Investigation/Physical Characteristics

Purpose and Scope

Potentiometric surfaces were determined to establish the direction of groundwater flow and potential pathways for contaminant migration via groundwater. Measurements have to be repeated monthly to evaluate the potential for seasonal variation in potentiometric surfaces and direction of groundwater flow.

Static water levels were taken in all wells installed during the Remedial Investigation and in all existing observation wells on April 12, 1990, May 11, 1990 and June 8, 1990. Staff gauge measurements were obtained on April 12, 1990, May 11, 1990 and June 8, 1990. Additional monthly water level measurements are scheduled.

Slug tests were performed in shallow, intermediate and deep wells to estimate the horizontal hydraulic conductivity in the immediate vicinity of the selected wells. The Remedial Investigation resulted in the performance of 17 slug tests, including 4 duplicates. The tested wells were SW-4, SW-8, SW-9, SW-11, SW-15, SW-17, IW-1, IW-2, IW-3, IW-4, IW-5, DW-1, DW-2, and DW-3. Slug test results are summarized in Appendix G.

Methodology

Slug testing procedures conformed with approved Remedial Investigation protocols. Slug tests were performed using a Hermit Environmental Data Logger, Model SE1000B with field data recorder. Test methodology is described in the following paragraphs.

Three initial static water level measurements were obtained using an electronic static water level indicator in each observation well. A transducer, measuring water level changes with a precision of

0.01 feet, was lowered into the well a sufficient depth such that displacement of a known volume of water would not interfere with maintaining the transducer below saturation during the test period. The transducer cable was secured to the casing. The transducer water level was then allowed to equilibrate to initial static water level conditions or recover at least 90% in the condition of slow recharge (greater than 30 minutes).

A solid, cylindrical polypropylene slug was submerged in the well displacing either 0.5 or 0.75 gallons depending on the number of sections used. The well was then allowed to return to the initial static water level or recover at least 90% in the condition of slow recharge. Slow recharge occurred in wells, SW-8, SW-11, SW-15 and DW-3. Duplicate tests were performed on SW-9A, IW-1, IW-4, IW-5 and DW-3.

Slug test data was evaluated using the Bouwer and Rice Method. All calculations assumed the effective well diameter was six inches and that the effective screen diameter was two inches. Other assumptions used for the calculation of horizontal hydraulic conductivity and transmissivity are presented in Appendix G.

2.2 Technical Memorandum

A Phase I Data Completeness Technical Memorandum (Technical Memorandum) was submitted on June 1, 1990. This Technical Memorandum discusses the purpose, scope and completeness of all field activities. The field activities included background sampling, soil sampling, groundwater sampling, surface water sampling, and sediment sampling for chemical analyses; physical parameter testing of soils; potentiometric surface determination; and slug tests. The Technical Memorandum presents preliminary discussions of the physical characteristics and the nature and extent contamination in soils, groundwater, surface water and sediments at the Hi-Mill site. The Technical Memorandum also evaluates the adequacy of data and recommends modifications to the scheduled second round of groundwater sampling. The Technical Memorandum's table of contents with lists of figures, tables and appendices is presented as Appendix E. Some of the Tables, Figures and Appendices presented in the Technical Memorandum have been corrected, modified or expanded for inclusion in this Draft Remedial Investigation and Baseline Risk Assessment Report.

The Technical Memorandum concluded that assessment sampling met the data completeness requirements and were in fact 100% complete in all but the following areas: soil sampling appeared to be only 95% complete but was being recalculated, Atterberg limit testing was 89% complete, horizontal hydraulic conductivity testing was 93% complete, and QA/QC samples were 100% complete except for the absence of three field duplicates for pH, specific conductivity, and temperature during groundwater sampling, the absence of one Atterberg limit field duplicate, and the absence of one permeability field duplicate.

Recalculation of soil sample completeness identified ten uncounted samples and results in a corrected completeness calculation of greater than 98%. Reexamination of slug test data revealed that SW-4 was tested but failed to recharge. Therefore, slug test completeness is recalculated as 100%.

The Technical Memorandum concluded that chemical and physical measurements were over 99% complete for inorganic analyses and 98.4% complete for organic analyses. No significant laboratory QA/QC deficiencies were identified. However, a data review indicated that eight surface water and four groundwater samples had elevated nickel values that were the result of a systematic analysis error. These samples have been reanalyzed by Wilson Laboratories.

The Technical Memorandum concluded that all required measurements of groundwater static water levels were performed. However, additional monthly measurements are scheduled. This Draft Remedial Investigation and Baseline Risk Assessment Report includes results from measurements of groundwater static water levels on June 8, 1990 that were not included in the Technical Memorandum.

3.0 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

3.1 Surface Features

Surface features of the Hi-Mill site are depicted on Figure 1-2, and Plates I, II and III. These plates and figure show an area that consists of both natural and man-made features.

Natural features exhibit a topography typical of nearby areas within the glacial interlobate morainic system. Closed depressions dot a surface controlled by glacial moraine and/or outwash features. Drainage is poorly developed and generally deranged. Waterbury Lake, the Hi-Mill facility and the Target Wetland all occupy a gently sloping (generally less than 2% except for the slope to Waterbury Lake which reaches more than 10% locally) area ranging in elevation from approximately 999 feet to 1010 feet NGVD. Irregularly shaped upland areas locally extend to elevations of 1034.8 feet (directly east of Numatics), 1032.2 feet (northeast of Waterbury Lake and 1028.7 feet (north of M-59).

Man-made features are dominated by the M-59 roadway, drainages and nearby structures. M-59 is a four-lane, divided, asphalt-pavement highway with limited access. Culverts pass beneath the roadway from both the Target Wetland and the north arm of Waterbury Lake.

Hi-Mill consists primarily of enclosed, paved or fenced areas. The Hi-Mill buildings occupy approximately 50,000 square feet. The parking areas (primarily paved) cover approximately 60,000 square feet of the site. An eight-foot high, chain-link fence, topped with barbed wire surrounds the approximately two-acres of unimproved Hi-Mill property that lie south and east of the production building.

Numatics, Inc is located approximately 800 feet northeast of the Hi-Mill facility. Numatics occupies a production building approximately 12,000 square feet in size on a two to three acre site. Approximately 22,000 square feet of the site is used for vehicular parking and traffic. Several rural residences lie over 1000 feet east of the Hi-Mill site on the west side of Waterbury Road.

3.2 Surface Water Hydrology

The surface water hydrology of the Hi-Mill site is dominated by the presence of Waterbury Lake and the Target Wetland. These waterbodies are surficially unconnected, and both lie within closed basins without any external drainage. Waterbury Lake is approximately thirty-five to forty acres in size. The Target Wetland is approximately eight to ten acres in size.

The north arm of Waterbury Lake, which is isolated from the main Waterbury Lake body, drains north beneath M-59 to a small pond that drains north to Alderman Lake. Alderman Lake in turn drains to the south through Pettibone Creek. Pettibone Creek flows south into Pickerel Lake, which in turn drains south into Lower Pettibone Lake.

The Target Wetland under normal conditions is isolated with no outlet. During periods of high water elevations in the Target Wetland, it may be connected via a culvert to a small, shallow wetland north of M-59. This small shallow wetland has no external drainage.

Water levels in both Waterbury Lake and the Target Wetland fluctuate seasonally as indicated by staff gauge readings, vegetation and historic aerial photographs. Measurements of these fluctuations are presented in Table 3-1. Locations of the six staff gauges used for these measurements are shown on Figure 2-4.

Staff gauge measurements from April 12, May 11 and June 8, 1990 for staff gauges SG-1, SG-2 and SG-6 were averaged to determine flow potential between the Target Pond and a small wetland directly across M-59 to the north. Average surface water elevations for staff gauges in the Target Pond are 1005.55 feet (SG-2) and 1005.51 feet (SG-1). Average surface water elevation in the shallow wetland north of M-59 was 1005.34 feet (SG-6). These staff gauge data indicate a slight potential for surface water flow toward the north, but field observation show that the base of the culvert passing from the Target Pond beneath M-59 is above the recorded water levels in the Target Pond. This field observation does not indicate a direct connection between the Target Pond and the shallow wetland north of M-59. , which is north of M-59.

Staff gauge measurements from April 12, May 11 and June 8, 1990 for staff gauges SG-3, SG-4, and SG-5 were averaged to determine flow potential between water bodies of Waterbury Lake, the isolated north arm of Waterbury Lake, and a wetland directly across M-59 to the north. Average surface water elevations for staff gauges in Waterbury Lake is 1000.08 feet (SG-4). The average

Hi Mill Manufacturing Company
Remedial Investigation

Table 3-1

Part A
Shallow Aquifer
Potentiometric Surface Data

Well No.	Coordinates East	North	Top of Casing Elevation	4/12/90 SWL/GWE	5/11/90 SWL/GWE	6/8/90 SWL/GWE
SW 1	4836.64	5161.85	1,013.17	8.72/1,004.45	9.11/1004.06	9.18/1003.99
SW 2	4195.70	5232.68	1,018.04	19.60/998.44	18.62/999.42	17.99/1000.05
SW 3	4835.29	5493.89	1,012.43	4.41/1,008.02	4.96/1007.47	4.71/1007.72
SW 4	4801.81	5856.60	1,010.18	3.64/1,006.54	4.21/1005.97	4.41/1005.77
SW 5	4961.10	5476.12	1,011.95	4.00/1,007.95	4.57/1007.38	7.82/1004.13
SW 6	4977.80	5336.34	1,011.63	3.37/1,008.26	4.00/1007.63	3.94/1007.69
SW 7	5036.95	5478.99	1,010.36	4.12/1,006.24	4.31/1006.05	4.62/1005.74
SW 8	5108.19	5393.99	1,010.85	3.70/1,007.15	4.85/1006.00	5.22/1005.63
SW 9	4974.48	5669.81	1,010.10	4.42/1,005.68	4.72/1005.38	4.84/1005.26
SW 9A			1,010.88			4.84/1006.04
SW 10	5112.85	5490.56	1,010.50.	4.48/1,006.02	5.02/1005.48	4.80/1005.70
SW 11	4913.90	4918.55	1,013.04	10.0/1,003.04	10.37/1,002.67	10.71/1002.33
SW 12	5029.18	5097.04	1,013.14	3.16/1,009.98	3.71/1009.43	4.07/1009.07
SW 14	5247.52	5304.50	1,009.76	5.18/1,004.58	5.31/1004.45	5.77/1003.99

Hi Mill Manufacturing Company
Remedial Investigation

Table 3-1 Con't

Part A Con't
Shallow Aquifer
Potentiometric Surface Data

Well No.	Coordinates East	North	Top of Casing Elevation	4/12/90 SWL/GWE	5/11/90 SWL/GWE	6/8/90 SWL/GWE
SW 15	5380.41	5262.08	1,010.93	3.62/1,007.31	4.31/1006.57	6.65/1004.28
SW 17	5877.47	5286.53	1,012.83	12.74/1,000.09	12.85/999.98	12.78/1000.0
SW 18	6150.44	5866.12	1,008.58	6.28/1,002.30	6.41/1002.17	6.43/1002.1
SW 19	5917.08	6146.97	1,015.61	11.94/1,003.67	11.89/1003.72	11.86/1003.7
SW 20	5024.46	6420.24	1,009.76	2.27/1,007.54	2.96/1006.80	2.26/1007.5
SW 21	4773.86	5467.87	1,012.93	5.39/1,007.54	NM/	DAMAGED
SW 22	5066.25	5550.10	1,010.25	4.27/1,005.98	4.62/1005.63	4.72/1005.5

Hi Mill Manufacturing Company
Remedial Investigation

Table 3-1 Con't

Part B: Intermediate and Deep Aquifers - Potentiometric Surface Data

				Groundwater Elevation Data		
	Coordinates		Top of Casing	4/12/90	5/11/90	6/8/90
Well No.	East	North	Elevation	SWL/GWE	SWL/GWE	SWL/GWE
IW 1	4201.32	5224.28	1,017.02	20.45/996.57	20.42/996.60	20.40/996.62
IW 2	4930.85	5069.05	1,014.56	16.49/998.07	16.47/998.09	16.34/998.22
IW 3	4835.32	5498.20	1,011.90	13.38/998.52	13.37/998.53	13.22/998.68
IW 4	4796.28	5857.73	1,010.06	11.19/998.87	11.24/998.82	11.16/998.90
IW 5	5242.66	5314.18	1,009.39	10.40/998.99	10.41/998.98	10.36/990.03
DW 1	4929.12	5078.70	1,014.62	17.37/997.25	17.26/997.36	17.17/997.4
DW 2	4835.83	5502.14	1,011.99	14.09/997.83	14.02/997.97	13.96/998.03
DW 3	5237.63	5323.86	1,009.41	12.02/997.39	11.90/997.51	11.84/997.57

Hi Mill Manufacturing Company
Remedial Investigation

Table 3-1 Con't

Part B: Intermediate and Deep Aquifers - Potentiometric Surface Data

Well No.	Coordinates East	North	Top of Casing Elevation	Groundwater Elevation Data 4/12/90 SWL/GWE	5/11/90 SWL/GWE	6/8/90 SWL/GWE
IW 1	4201.32	5224.28	1,017.02	20.45/996.57	20.42/996.60	20.40/996.62
IW 2	4930.85	5069.05	1,014.56	16.49/998.07	16.47/998.09	16.34/998.22
IW 3	4835.32	5498.20	1,011.90	13.38/998.52	13.37/998.53	13.22/998.68
IW 4	4796.28	5857.73	1,010.06	11.19/998.87	11.24/998.82	11.16/998.90
IW 5	5242.66	5314.18	1,009.39	10.40/998.99	10.41/998.98	10.36/990.03
DW 1	4929.12	5078.70	1,014.62	17.37/997.25	17.26/997.36	17.17/997.4
DW 2	4835.83	5502.14	1,011.99	14.09/997.83	14.02/997.97	13.96/998.03
DW 3	5237.63	5323.86	1,009.41	12.02/997.39	11.90/997.51	11.84/997.57

Hi Mill Manufacturing Company
Remedial Investigation

Table 3-1 Con't

Part C: MDNR Wells Potentiometric Surface Measurements

Well No.	Coordinates East	North	Top of Casing Elevation	4/12/90 SWL/GWE	4/19/90 SWL/GWE	5/11/90 SWL/GWE	6/8/90 SWL/GWE
EW1	4942.94	5703.00	1008.05	1.32/1006.73	1.78/1006.27	2.12/1005.93	1.28/1006.77
EW2	5052.12	5585.79	1007.33	1.40/1005.93	0.49/1006.84	1.74/1005.59	1.49/1005.84
EW3	5088.89	5523.17	1010.82	NM	4.93/1005.89	5.14/1005.68	
EW4	5151.44	5449.37	1009.94	3.8/1006.14	3.94/1006	4.24/1005.70	4.16/1005.78

Hi Mill Manufacturing Company
Remedial Investigation

Table 3-1 Con't

Part D
Staff Gauge: Water Surface Elevation Data

Gauge Number/ Map Number	Coordinates East	North	Gauge Elevation @ 6 Foot Mark	Guage Reading/Elevation 4/12/90 GR/Elev	5/11/90 GR/Elev	6/8/90 GR/Elev
Target Pond						
SG1 Near TP4 86	**4943.99**	**5865.77**	**1007.76**	**3.94/1005.70**	**3.70/1005.46**	**3.63/1004.36**
SG2 SE 90	5692.28	5513.71	1005.97 (@6.5' Mark)	6.27/1005.74	6.0/1005.47	5.96/1005.43
SG6 North of M-59 154	4588.97	6250.34	1006.85	4.71/1005.56	4.40/1005.25	4.36/1005.21
Waterbury Lake						
SG WL1 235	6131.12	4840.50	999.31	6.17/999.48	6.15/999.46	6.26/999.57
SG WL2 232	4959.72	4679.41	999.97	6.36/1000.33	6.06/1000.03	5.92/999.89
North M-59						
SG 229	4501.74	4642.23	1006.67	3.30/1003.97	3.28/1003.95	3.32/1003.99

surface water elevation in the isolated north arm of Waterbury Lake is 999.50 feet (SG-3). The average surface water elevation in the wetland directly north of M-59 is 1003.97 feet (SG-5). These three staff gauges indicate what appears to be three discontinuous water bodies that step downward to the south. Field observations confirm that the staff gauges are in water bodies that are discontinuous.

Measured monthly fluctuations in staff gauge readings are as great as -0.35 feet between April and May at Staff Gauge 6 and as small as -0.02 feet between April and May at staff gauges, SG-3 and SG-5. Measured monthly fluctuations have all been downward except for an increase of 0.04 feet and 0.11 feet at staff gauges SG-3 and SG-5, respectively. The maximum total fluctuation over the two-month period of record is a decline in surface water level at staff gauge SG-6 of 0.35 feet. Surface water fluctuations result from an uneven temporal distribution of average annual precipitation (approximately 32 inches), temporal changes of evapotranspiration rate (estimated to be 32 inches a year from free water surfaces) and either a small gain or loss to groundwater.

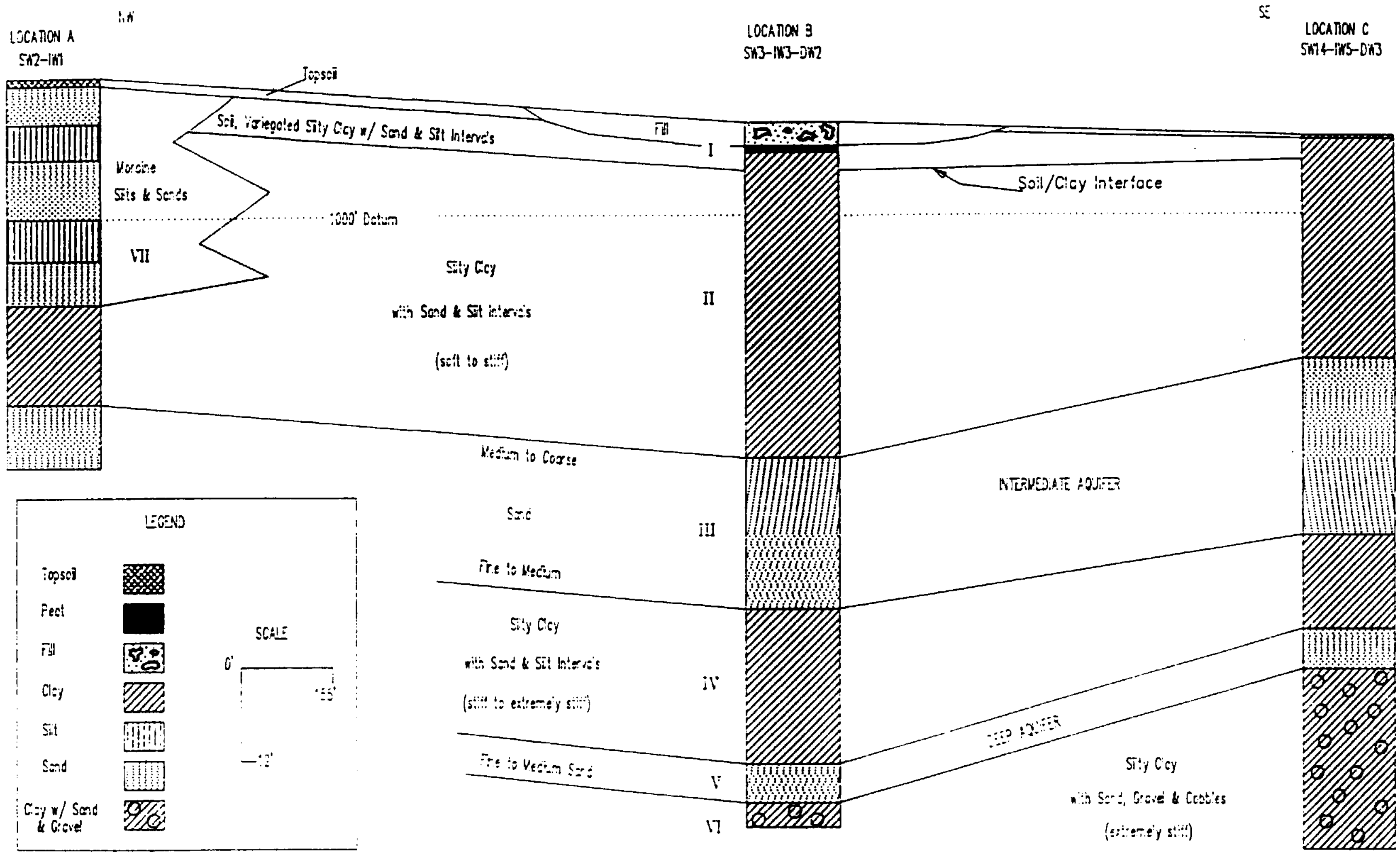
The Target Wetland appears to be an exposed groundwater surface, and it is not known whether it receives a net gain or loss from groundwater. Waterbury Lake also appears to be an exposed groundwater surface, although this conclusion is less certain due to the absence of observation wells to the south and west. The shallow groundwater contour map presented in this document (Figure 3-3) was generated assuming that the Target Wetland and Waterbury Lake are exposed groundwater surfaces.

3.3 Geology

Figure 3-1 is an interpretive soil-type cross-section trending northwest (NW) to southeast (SE) across the site. This cross-section is constructed from a composite of sample descriptions from nested well borings at SW-2/IW-1 (location A), SW-3/IW-3/DW-2 (location B) and SW-14/IW-5/DW-3 (location C). Locations of these nested wells are shown in Figure 2-4. Soil boring logs are presented as Appendix F.

The NW location A is typical of higher moraine ridge soil structure with a thin surface veneer of sandy-clay topsoil, fine sands, silts and/or gravel mixtures. Shallow wells SW-17, SW-18, and SW-19 are located in these ridge-type deposits. Silty lacustrine clay lies beneath the ridge deposits. This silty lacustrine clay is blue/grey to tan with inhomogeneities ranging from varves to thin intervals

Figure 3-1. Conceptual Geologic Cross Section.



of silt, fine silty sand or sand. Beneath the lacustrine clay is a zone of glacial outwash (intermediate aquifer). This saturated zone is generally composed of medium to coarse sands that grade with depth to fine to medium sands. These deposits were encountered at locations B and C and may have been encountered near the bottom of location A. The intermediate aquifer is separated from another zone of glacial outwash (deep aquifer) by another lacustrine deposit. This lacustrine deposit is a blue/grey silty clay similar in character to the upper lacustrine clay except for greater stiffness and
somewhat thicker and coarser inhomogeneities. This lacustrine deposit is approximately 20 to 25 feet thick at locations B and C but thins considerably at DW-1 (two to three feet thick).

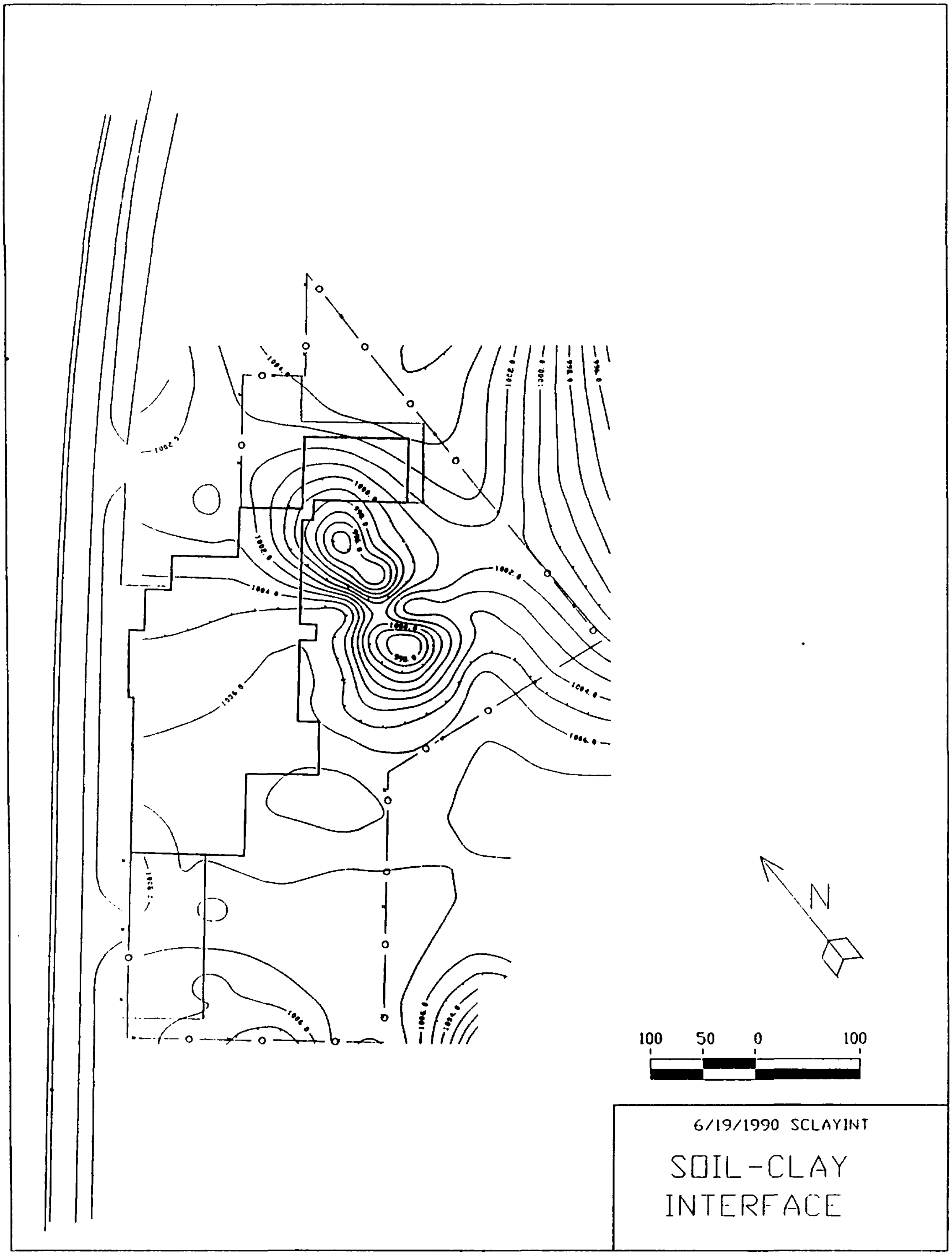
Beneath this lacustrine deposit is another saturated zone (deep aquifer). This second saturated zone is glacial outwash. This zone appears to be less than 10 feet in thickness and is a fine to medium grained grey sand. At location C a blue/grey silty clay with sand, gravel and cobbles underlies the deep aquifer. This till layer was not encountered at the other two deep borings.

Lateral discontinuities are commonly present in the types of glacial deposits described above. The limited number of data points facilitate multiple possible correlations of units. For this reason all interpolated unit boundaries are considered to be only conceptual representations. The shallow sediments at the site have more numerous data points for possible correlation. The clay interface contour map (Figure 3-2) shows that the contact surfaces are irregular and thin zones may be expected to be laterally discontinuous.

3.4 Soils

Site soils encountered during the Remedial Investigation were clay, silt, organic clay, peat, silt, sand, mixtures of the preceding soil types and fill materials ranging from sand and gravel to clayey sand. Soil boring logs are presented in Appendix F. Soil types for all soil samples are summarized on the soil sample master data table in Appendix C. This data table identifies soils based upon grain-size as one of the following twelve groups: peat (P), clayey topsoil (CT), sandy topsoil (SDT), organic silty clay (OSTC), silty clay (STC), sandy clay (SDC), silty clay with sand or silt lamina, lenses or beds (STC/LB), clayey silt (CST), clayey sand (CSD), silty sand (STSD), sand (SD) and sandy gravel (SDG).

Figure 3-2. Soil-Clay Interface Elevation Contour Map



Analysis of soil physical characteristics were performed on selected split spoon samples from confining clay layers and saturated zones. These analyses indicate that moisture contents range from 12% to 31%; liquid limits, plastic limits and plasticity indices range from 25.5 to 42.9, 16.0 to 25.5 and 9.5 to 22.1, respectively; and vertical permeabilities range from 1.4 x 10^{-2} centimeters/second to 7.46 x 10^{-8} centimeters/second. Results of physical soil characteristic analyses including the results of sieve analyses are presented in Appendix J.

The depth to the clay interface was determined in the field at each boring and was used to select sample depths. Clay depths varied from 1008' to 997' NGVD. Depth to clay contours are presented on Figure 3-2. This figure shows that the clay interface elevation varies from approximately 995 feet to 1008 feet NGVD. Depressions in the clay contour map appear to coincide with the area of the two former lagoons. A subsurface slay ridge is present between the Hi-Mill facility and Waterbury Lake. Other contours appear to slope toward the Target Wetland.

Site soils are generally described by the U.S.D.A. Soil Conservation Service as belonging to five map units (Soil Survey of Oakland County, Michigan). These five units are 1) Houghton and Adrian mucks encircling the Target Pond, 2) Kibbie fine sandy loam located on the broad knoll between the Target Wetland and Waterbury Lake, 3) Thetford loamy fine sand southwest of the Hi-Mill facility along both sides of M-59, 4) Aquents, sandy and loamy, undulating in the immediate vicinity of the Hi-Mill facility, and 5) Tedrow loamy sand on the ridge east of the Target Wetland and in the area immediately around the Numatics facility. Runoff for all of these soil groups is classified as slow except for the Houghton and Adrian Muck which has very slow runoff. Permeabilities of these materials ranges from moderately slow to moderately rapid except for the Tedrow loamy sand which has rapid permeability.

3.5 Hydrogeology

Hydrogeologic Units

Six distinct hydrogeologic units were encountered during the Remedial Investigation. These hydrogeologic units shown on Figure 3-1 are as follows: I, shallow soils and granular materials; **II**, periglacial and/or post-glacial lacustrine deposits; **III**, glacial outwash deposits; **IV**, periglacial or interglacial lacustrine deposits; V, glacial or periglacial outwash deposits; VI, till; and VII, the upland area east of the Target Pond and northwest of the Hi-Mill facility across M-59 are glacial outwash or morainal deposits. Shallow soil and granular material are described as hydrologic unit I. Hydrogeologic I is predominantly silt, sand clay mixtures that locally contain well developed soil horizons, plant roots, areas of fill and thin zones of high organic content. This hydrogeologic unit generally is saturated near its base, but in most locations is too shallow to facilitate installation of monitor wells. Monitoring well SW-5 is the only monitor well thought to be screened entirely in hydrogeologic unit I. The soil-clay interface, used to select sample depths during the Remedial Investigation, is the boundary between hydrogeologic zones I and II. Monitor wells SW-3, SW-9A, SW-12, SW-20, SW-21, SW-22, EW-1, EW-2, EW-4, and EW-6 are screened across this soil-clay interface and straddle hydrogeologic zones I and II. Analysis of slug test data from SW-9A indicates a horizontal hydraulic conductivity of 2.25 x 10^{-3} cm/sec. for zone I/II wells.

Lacustrine clays are described as hydrogeologic unit II. Hydrogeologic unit II is a blue/gray to tan variegated silty clay with horizontal bedding varying from varves to thin silt or silty sand interbeds. Blue/grey color appear to be more prevalent with depth but periodic occurrences of tan beds and the occurrence of shallow blue/grey beds suggest that color is not a valuable correlation parameter. Silty clays varied in moisture content from moist to saturated while silt and silty sand seams all appeared to be saturated. Localized pathways for horizontal migration in hydrogeologic zone II may be present, but the zone is expected to be an effective barrier to vertical migration. Monitor wells SW-1, SW-4, SW-6, SW-7, SW-8, SW-10, SW-11, SW-14 and SW-15 are thought to be screened entirely within hydrogeologic zone II. Analysis of slug test data from SW-4, SW-8, SW-11 and SW-15 provide a range of horizontal hydraulic conductivities ranging from less than 1.53 x 10^{-5} cm/sec. to 8.77 x 10^{-5} cm/sec.

Hydrogeologic zone III is glacial outwash. Hydrogeologic zone III consists of sands that grade from medium to coarse at the top of the zone to fine to medium at the base of the zone. This hydrogeologic zone produces useable amounts of water and was tapped by Hi-Mill's abandoned western water supply well. Monitor wells IW-1, IW-2, IW-3, IW-4, IW-5 and SW-17 are thought to be screened entirely within hydrogeologic zone III. Analysis of slug test data from SW-17, IW-1, IW-2, IW-3, IW-4, and IW-5 indicate horizontal hydraulic conductivities ranging from 5.63 x 10^{-4} cm/sec. to 1.09 x 10^{-2} cm/sec.

Hydrogeologic zone IV is a stiff to extremely stiff blue/grey silty clay with thin sand and silt intervals. This zone appears to be approximately 20 feet thick at DW-2, 12 feet thick at DW-3, but only 1 foot thick at DW-1. This zone, when present, is expected to provide an effective barrier to vertical migration. No wells are screened in this hydrogeologic zone.

Hydrogeologic zone V is a fine to medium sand similar to hydrogeologic zone III. This hydrogeologic zone produces useable amounts of water and is currently tapped by the Hi-Mill water supply well. Hi-Mill's abandoned eastern water supply well was screened in this hydrogeologic zone.

Monitor wells DW-1, DW-2, and DW-3 are screened in this hydrogeologic zone. Analysis of slug test data from DW-1, DW-2 and DW-3 indicate horizontal hydraulic conductivities for zone V wells ranging from 1.04×10^{-3} cm/sec to 2.20×10^{-3} cm/sec.

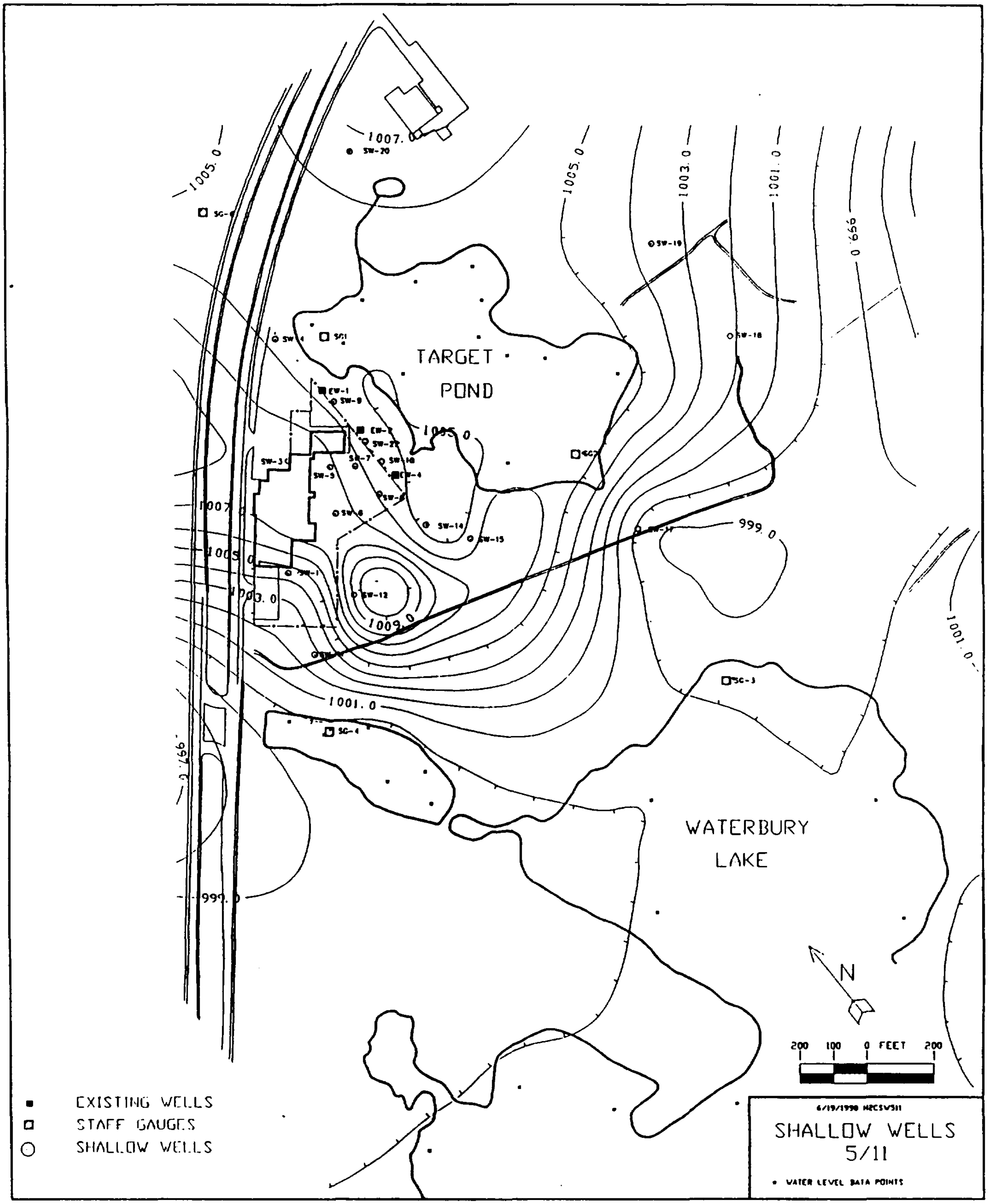
Hydrogeologic zone VI is an extremely stiff clay till. This zone was encountered at DW-3 and may have been encountered at the base of DW-2. This hydrogeologic zone is expected to be an effective barrier to vertical migration when present.

Hydrogeologic zone VII is a surficial deposit encountered during the remedial investigation in upland areas to the east of the Target Wetland and northwest of M-59. Hydrogeologic zone VII is predominantly silts and sands with some zones of clay and occasional gravel and cobbles. This zone is expected to be an area of groundwater recharge. Monitor wells SW-2, SW-18 and SW-19 are screened in hydrogeologic zone VII.

Hydraulic Potential

Potentiometric surfaces at monitor well locations were measured on April 12, 1990, May 11, 1990 and June 8, 1990. Measurements of potentiometric surface elevations are presented in Table 3-1. The average variation in shallow well potentiometric surfaces was -0.18 and -0.32 feet April 12 and May 11 and May 11 and June 8, respectively. Wells SW-2, SW-5, SW-8, SW-15, SW-17, SW-19, SW-20 and SW-21 have potentiometric surfaces that seem to be fluctuating differently than the other shallow wells, which appear to show similar fluctuations. A potentiometric contour map (May 11, 1990 data) for shallow wells is presented as Figure 3-3. Some of the abrupt contour characteristics are thought to be a result of either the contouring program or the inclusion of dissimilar shallow wells in the data set. Examination of multiple sets of generated contours suggest that the bend around SW-17 results from its dissimilarity (hydrogeologic unit III) to other wells.

Figure 3-3. Shallow Well Potentiometric-Surface Contour Map (May 11, 1990 Data)



The mound just east of SW-12 is thought to result from the computer algorithm and is not expected to be present at the site. The shallow groundwater appears to be flowing generally south, as shown on Figure 3-3, although the potentiometric contours present an irregular surface. A northwestward component of flow may be present northwest of the Hi-Mill buildings. The relationship of the potentiometric surface in SW-2 to the other shallow well potentiometric surfaces is critical to this interpretation.

Potentiometric surface measurements varied with respect to time at all intermediate wells. The average variation in intermediate well potentiometric surfaces was +0.03 and +0.10 feet between April 12 and May 11 and May 11 and June 8, respectively. A potentiometric surface contour map (June 8, 1990 data) for intermediate wells is presented as Figure 3-4. The intermediate wells appear to show similar fluctuations, although IW-4 may be fluctuating differently than the other intermediate wells. This could be a result of its proximity to Hi-Mill's operating water supply well.

The intermediate groundwater appears to be flowing generally to the northwest, as shown on Figure 3-4. The contour map developed from potentiometric surfaces in the five intermediate wells is regular and has an average gradient of about 0.0027 feet/foot. Estimated groundwater velocity in the intermediate aquifer, based upon the average hydraulic gradient and the range of slug test hydraulic conductivities, is 16 feet to 310 feet per year.

Potentiometric surface measurements varied with respect to time at all deep wells. The average variation in deep well potentiometric surfaces was +0.11' and +0.07 feet between April 12 and April and May 11; and May 11 and June 6, respectively. A potentiometric surface trend map (June 8, 1990 data) for deep wells is presented as Figure 3-5. All three deep wells appear to show similar fluctuations. Deep ground water appears to be flowing southwest, as shown on Figure 3-5. The trend surface developed from potentiometric surfaces in the three deep wells appears flat and regular. The regularity of this picture is the result of having only three data points and may or may not reflect the actual potentiometric surface shape. The average groundwater gradient in the deep aquifer is approximately 0.0012 feet/foot. Estimated groundwater velocity in the deep aquifer, based upon the average hydraulic gradient and the range of slug test hydraulic conductivities, is 13 feet to 28 feet per year.

Comparison of potentiometric levels at well nests shows a downward vertical hydraulic gradient in all cases. Well nest SW-2 and IW-1 shows average potentiometric levels of 998.83 and 996.60 feet, respectively. Well nest IW-2 and DW-1 shows potentiometric levels of 998.08 and 997.33 feet,

Figure 3-4. Intermediate Well Potentiometric-Surface Contour Map (June 8, 1990 Data)

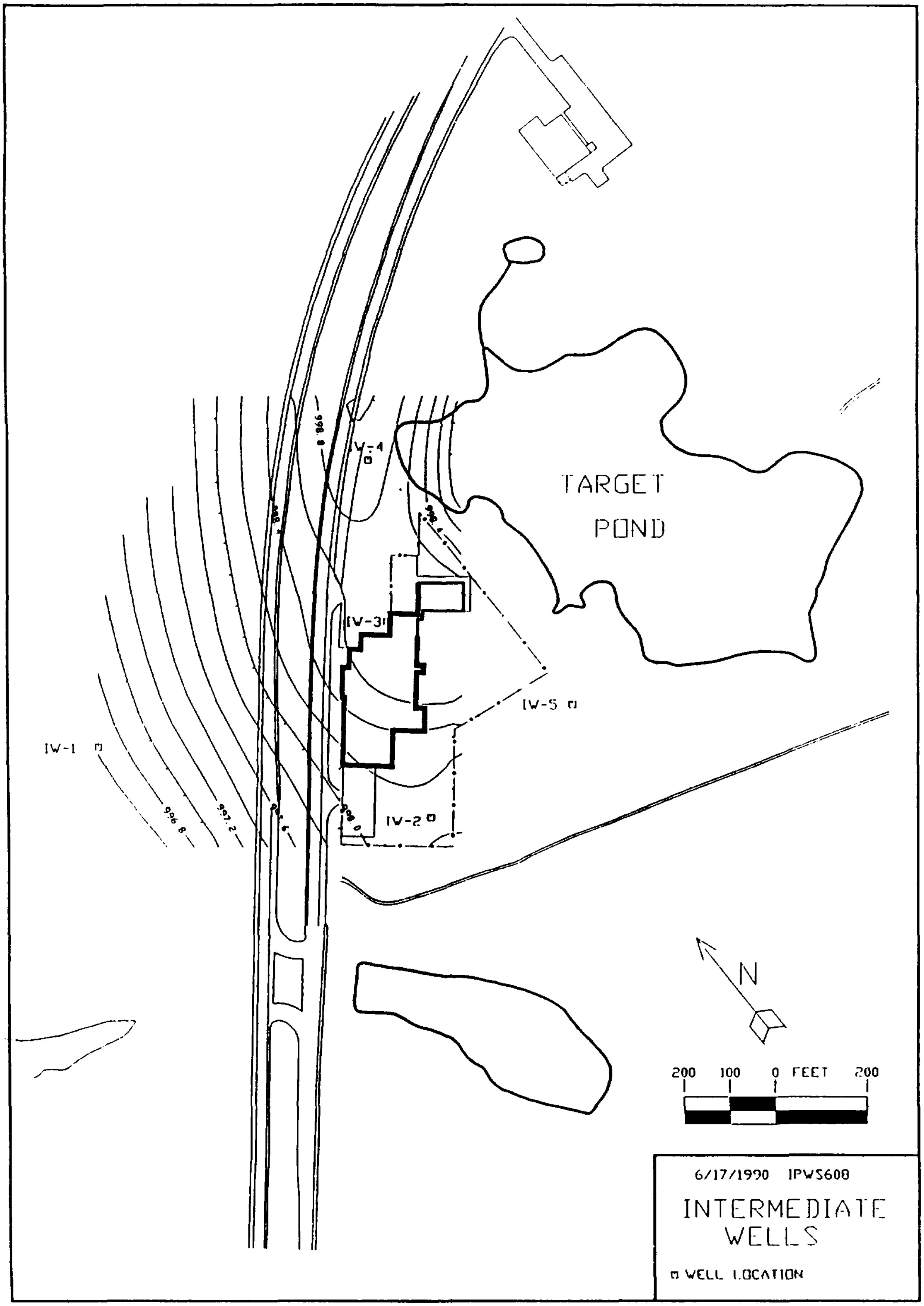
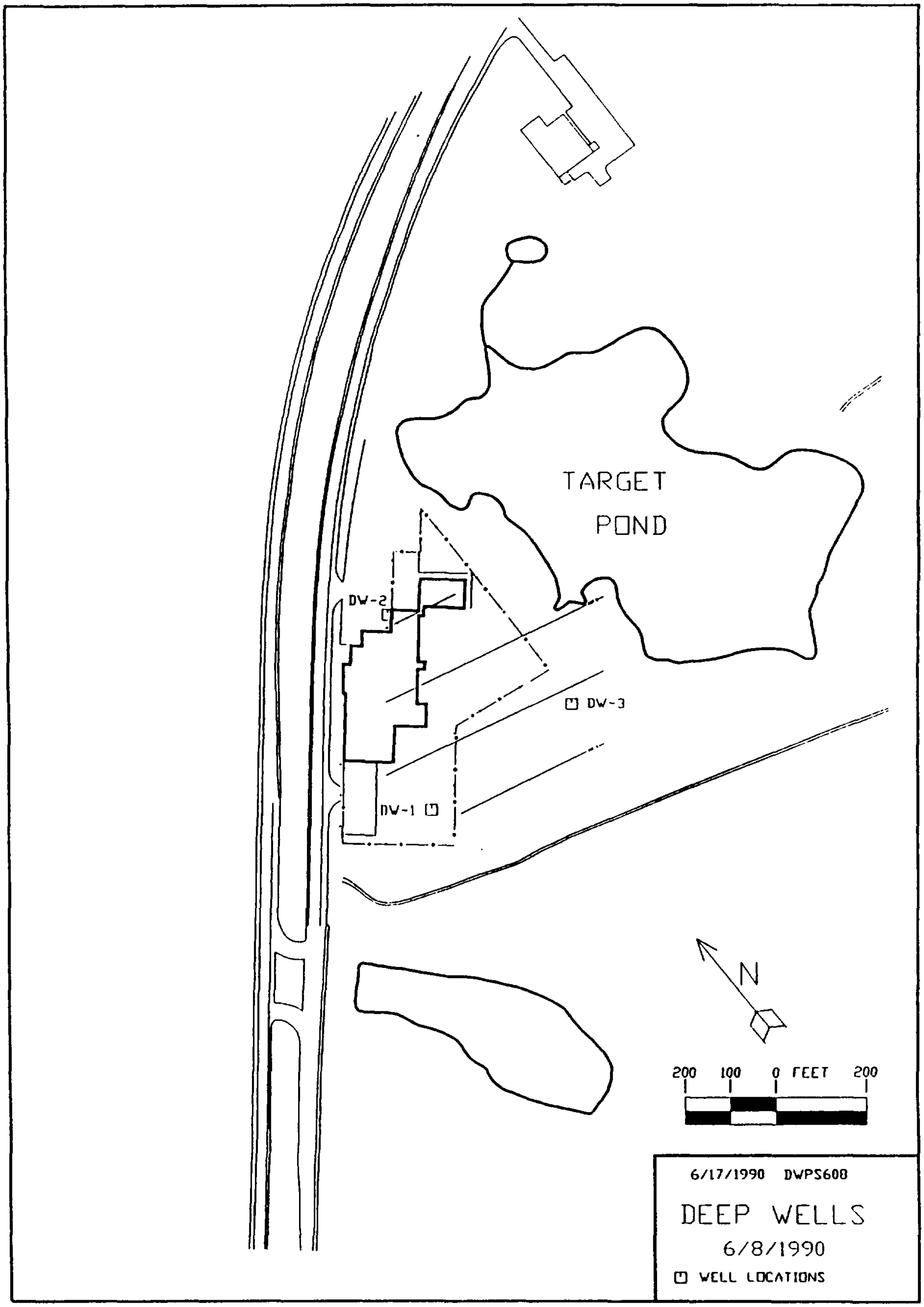


Figure 3-5. Deep Well Potentiometric-Surface Trend Map (June 8, 1990 Data)



respectively. Well nest SW-3, IW-3 and DW-2 shows potentiometric levels of 1007.74, 998.56 and 997.92 feet respectively. Well nest SW-4 and IW-4 shows potentiometric levels of 1006.25 and998.86 feet, respectively. Well nest SW-14, IW-5 and DW-3 shows potentiometric levels of 1004.53, 998.97 and 997.43, respectively.

Hydrogeologic Parameters

Physical soil tests and slug tests were performed to determine hydrogeologic characteristics. Atterberg limit testing, sieve analysis, moisture contents and vertical permeabilities were determined for typical fine and coarse grained materials. Results are presented in Appendix G. Vertical permeability testing of silty clays in hydrogeologic unit II included samples IW-4AD, SW-10C, SW-15A and IW-5A. Calculated vertical permeabilities ranged from 1.4 x 10^{-6} cm/sec to 7.46 x 10^{-8} cm/sec. Vertical permeability testing of medium to coarse sand in hydrogeologic unit III included samples IW-1C and IW-5C. Calculated vertical permeabilities ranged from 1.14 x 10^{-2} cm/sec to 6.98 x 10^{-3} cm/sec. Vertical permeability of silts and sands from hydrogeologic units IV and V included DW-1P, DW-1Q, DW-2K, DW-3C and DW-3D. Calculated vertical permeabilities ranged from 1.44 x 10^{-2} cm/sec to 8.12 x 10^{-6} cm/sec. The calculated values from these hydrogeologic units do not appear consistent with visual descriptions and may indicate the presence of thin lowpermeability horizontal layers. Sample DW-3F is from hydrogeologic unit VI and has a calculated vertical permeability of 1.67 x 10^{-7} cm/sec.

4.0 NATURE AND EXTENT OF CONTAMINATION

4.1 Soils

A soils master data table is presented as Appendix C. This master data list contains the sample ID, ENCOTEC laboratory sample number, boring type, sample collection date, project east location coordinate, project north location coordinate, elevation, sample depth category, and sample type.

4.1.1 Inorganics

Analyses for short list metals and TAL inorganics were performed on samples collected at the locations shown on Figure 2-3. Summary tables of analytical results for analyses of short list metals and TAL inorganics in soils are presented in Appendix H and I, respectively.

Short-list Metals

The identification of contaminants of concern was based on presence at concentrations above background criteria (BC). The background criteria was determined from chemical analysis of the representative background samples collected during the RI. A preliminary evaluation of the analysis data for the ten (10) background samples indicated that both samples collected at BG2 and one sample (BG4-1) collected at BG4 were not representative because the concentrations of several metals were clearly higher than the general trend observed in all other samples. BG2, being proximate to the manufacturing building and the M-59, is assumed to have been impacted by human activities . The sample from BG4-1, while not proximate to site activities, was observed in the laboratory to have significantly different soils characteristics when compared to the other samples. The analysis data from these three (3) apparently non-representative samples were omitted from all background calculations.

Analysis data from the seven (7) representative background samples were used to determine the BC. The BC was established as the mean, at the 95% confidence interval (mean value plus two (2) standard deviations) of all background measurements for a given analyte. When the analysis results were reported as below detection limit (U flag), the value of the detection limit and zero (0) were alternated in the mean calculation. In other words, the detection limit value was used for the first "U" flagged result encountered, zero (0) was entered for the next "U" flagged value, the detection limit value was used for the next "U" flagged result encountered, etc. The results from foreground sample analyses were then compared to the BC to determine which contaminants were present at elevated levels. This data then revealed the contaminants of concern and the extent of contamination.

Short list metal concentrations in background samples, including mean background concentrations and standard deviations are presented in Table 4-1. Table 4-2 presents soils analyses with short list metal concentrations above BC.

Table 4-1 shows that for copper, the mean background concentration is 4.3 mg/kg, the maximum background concentration is 7.5 mg/kg and that the BC is 8.33 mg/kg. There are 107 foreground locations above 8.33 mg/kg. There are 9 locations above 900 mg/kg. These nine locations of highest concentration are L3, M3, M4, H7, I5, H3/I3, I5-2, L3-2 and H7-2. An isoconcentration map showing the spatial distribution of copper concentrations in shallow soil samples is presented as Figure 4-1. A second isoconcentration map showing the spatial distribution of copper concentrations in clay interface soil samples is presented as Figure 4-2.

Table 4-1 shows that for chromium; the mean background concentration is 14.09 mg/kg, the maximum background concentration is 45.2 mg/kg, and that the BC is 39.7 mg/kg. There are 31 stations above 39.7 mg/kg. The highest concentration is 4420 mg/kg (M3-0). An isoconcentration map showing the spatial distribution of chromium in shallow soils is presented in Figure 4-3.

Table 4-1 shows that for zinc; the mean background concentration is 30.30 mg/kg , the highest background concentration is 70.2 mg/kg, and that the BC is 63 mg/kg. There are 38 stations above 63 mg/kg. The four highest detections are K6-0 (844 mg/kg), B1-0 (834 mg/kg), J5-0 (573 mg/kg), and E2-0 (350 mg/kg). It should be noted that the results of duplicate analysis for B1-0D (B1-0) is only 259 mg/kg.

Table 4-1 shows that for aluminum; the mean background concentration is 8054 mg/kg, the highest background concentration is 26,400 mg/kg and that the BC is 23,174 mg/kg. Six locations have values above 23,174 mg/kg. The highest concentration is 27,100 mg/kg at both H-7 and I-7.

Figure 4-1. Isoconcentration Map of Copper Concentrations in Surface Soil Samples

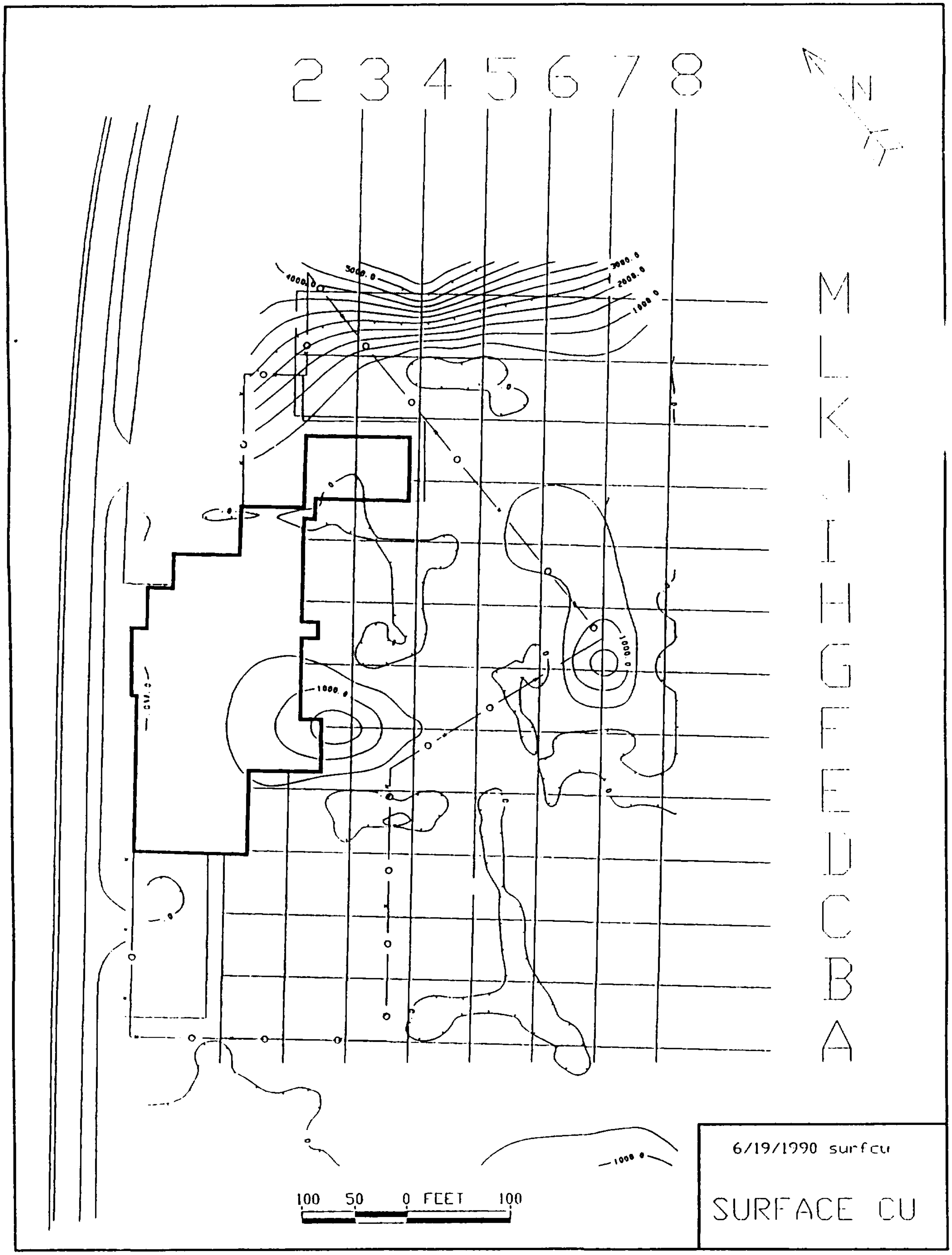


TABLE 4-1

SUMMARY OF BACKGROUND CONCENTRATIONS AND STATISTICS FOR SHORT LIST METALS IN SOILS

ANALYTE CONCENTRATIONS (mg/kg)

SAMPLE ID	ALUMINUM	CHROMIUM	COPPER	NICKEL	SILVER	ZINC
HMS-BG1-0	4330.00	7.50	3.00	5.40	2.30U	24.40
HMS-BG1-0D	4850.00	6.60	5.00	2.80U	2.30U	26.60
HMS-BG3-0	4760.00	8.00	5.80	4.90	2.40U	27.80
HMS-BG4-0	6710.00	12.60	2.50U	6.00	2.30U	20.90
HMS-BG5-0	3950.00	7.80	2.70U	6.00	2.40U	22.90
HMS-BG5-1	3900.00	8.00	2.30U	2.50U	2.10U	22.40
HMS-BG6-1	6330.00	9.50	6.40	3.80	2.10U	23.50
STATISTICAL ANALYSIS						
MEAN	4976	8.57	3.57	4.49	.96	24.07
STANDARD DEVIATION	1120	1.97	2.27	1.46	1.20	3.35
MEAN + 2 STD	7216	12.52	8.11	7.42	3.35	28.89

U = COMPOUND WAS ANALYZED FOR, BUT NOT DETECTED.

TABLE 4-2

SUMMARY OF SOIL SAMPLES ABOVE BACKGROUND CRITERIA
(MEAN + 2s)

ANALYTE CONCENTRATIONS (mg/kg)

SAMPLE ID	ALUMINUM	CHROMIUM	COPPER	NICKEL	SILVER	ZINC
HMS-A1-0		12.40		8.60		33.70
HMS-A1-1	8730.00	14.90	10.30	10.40		33.10
HMS-A2-0	12300.00	19.40	9.60	13.90		37.70
HMS-A2-1	8600.00	13.70	14.00	17.60		39.00
HMS-A3-0						33.60
HMS-A3-1	19500.00	32.40	24.10	28.70		52.30
HMS-A4-0	8620.00			8.70		36.50
HMS-B1-0	10200.00	18.60	112.00	15.50		259.00
HMS-B1-0D	11900.00	27.10	212.00	18.60	3.70	834.00
HMS-B1-1						
HMS-B2-0	13800.00	21.30	11.70	12.70		41.10
HMS-B2-1	14500.00	21.30	21.70	23.80		48.00
HMS-B3-0	8200.00	13.50	13.80	8.20		38.60
HMS-B3-1	24300.00	32.00	24.00	32.10		60.80
HMS-B4-0	7620.00			8.20		31.20
HMS-B5-0	7400.00					38.10
HMS-B5-0-D						35.70
HMS-C1-0	18100.00	25.40	24.40	31.70		53.40
HMS-C1-1	16900.00	25.30	16.20	26.60		49.10
HMS-C2-0	16000.00	21.90	16.60	18.40		42.10
HMS-C2-1	20400.00	27.40	16.30	26.20		48.10
HMS-C3-0	14100.00	19.20	10.30	14.70		47.40
HMS-C3-0D	14600.00	23.70		22.50		44.20
HMS-C3-1	19500.00	26.70	18.20	28.70		50.50
HMS-C4-0	8960.00	14.30	11.20	8.50		44.60
HMS-C5-0				8.20		30.70
HMS-D2-0	12200.00	23.10	289.00	17.30		332.00
HMS-D2-1	21100.00	29.90	19.10	26.90		41.90
HMS-D3-0						
HMS-D3-1	12200.00	18.60		19.40		40.60
HMS-D4-0	9720.00	53.40	14.40	14.00		44.00
HMS-D5-0						31.20
HMS-D6-0						
HMS-E2-0	10300.00	161.00	987.00	24.00		350.00
HMS-E2-1	13300.00	70.10	630.00	23.20		244.00
HMS-E3-0	10500.00	13.10	25.30	10.40		59.40
HMS-E3-1	18500.00	23.70	23.00	21.60		56.60
HMS-E4-0	8480.00		9.50	11.50		43.70
HMS-E5-0	11600.00	16.50	10.80	13.80		42.80
HMS-E6-0						32.10
HMS-E7-0	10400.00	18.70		16.40		38.70
HMS-F3-0	20800.00	68.90	1570.00	33.30		185.00
HMS-F3-0D	14100.00	44.70	1150.00	26.90		163.00
HMS-F3-1	22500.00	41.10	121.00	33.70		74.90
HMS-F4-0		14.20	524.00	10.70		103.00
HMS-F4-1	18900.00	31.30		27.70		56.20
HMS-F5-0	17500.00	26.30		19.90		55.80
HMS-F6-0						41.10
HMS-F7-0	8510.00			9.40		37.10
HMS-F7-0-D	7340.00			9.40		35.80

TABLE 4-2 (CONT)

SUMMARY OF SOIL SAMPLES ABOVE BACKGROUND CRITERIA
(MEAN + 2s)

ANALYTE CONCENTRATIONS (mg/kg)

SAMPLE ID	ALUMINUM	CHROMIUM	COPPER	NICKEL	SILVER	ZINC
HMS-F8-0	12300.00	15.50	7.80	19.20		44.80
HMS-G3-0			18.10			33.20
HMS-G3-1	20300.00	30.10	11.40	22.20		42.10
HMS-G3/H4-0			10.80			
HMS-G3/H4-1		13.40	28.10	11.70		33.20
HMS-G3/H4-2		118.00	222.00	12.90		73.10
HMS-G3/H4-3	17100.00	28.20	22.40	27.60		59.10
HMS-G4-0						
HMS-G4-1				10.10		34.40
HMS-G4-2			12.70			
HMS-G4-2D				9.00		
HMS-G4-3	11100.00	22.00		22.80		46.30
HMS-G5-0		14.60	25.10	14.70		40.50
HMS-G5-2	22200.00	34.30	25.20	33.00		62.30
HMS-G6-0				12.10		42.30
HMS-G6-1	19500.00	36.60	37.00	34.60		61.20
HMS-G6-2	15800.00	20.00		25.90		48.60
HMS-G6-3	17500.00	26.80	20.10	28.00		53.50
HMS-G7-0	12100.00	139.00	1480.00	27.50	22.50	664.00
HMS-G8-0	18100.00	20.50	14.50	18.00		49.60
HMS-H3-0		17.90	54.50			34.70
HMS-H3/I3-0		50.00	201.00	9.00		34.20
HMS-H3/I3-1	9170.00	248.00	1850.00	21.50		89.40
HMS-H3/I4-1						
HMS-H3/I4-2	10800.00	89.50	615.00	15.20		84.50
HMS-H3/I4-3	13700.00	21.60		26.50		56.70
HMS-H4-0						32.60
HMS-H4-1		48.00	68.20	16.00		53.80
HMS-H4/I5-0		15.60	19.40	9.40		47.40
HMS-H4/I5-1		13.40	29.60	8.60		87.00
HMS-H4/I5-3	9940.00	17.80	10.10	22.50		46.50
HMS-H5-0	9810.00	108.00	373.00	15.20		81.70
HMS-H5-1	14300.00	24.10		19.80		33.30
HMS-H6-0	8920.00	32.10	57.60	15.70		44.60
HMS-H6-0D	8950.00	63.70	105.00	18.50		43.00
HMS-H6-1	18300.00	97.00	309.00	30.20		60.70
HMS-H6-2	13200.00	24.30		19.60		39.40
HMS-H6-3	11300.00	13.30		25.10		40.00
HMS-H7-0	18200.00	196.00	813.00	30.70		107.00
HMS-H7-1	27100.00	615.00	2500.00	27.90		89.70
HMS-H7-2	15900.00	23.10	23.90	25.90		81.20
HMS-H7-3	19000.00	22.50		34.00		62.70
HMS-H8-0	21500.00	36.80	770.00	22.20		90.90
HMS-I3-1		17.40	32.90	9.00		47.20
HMS-I3-2	9330.00	16.70	11.90	12.50		41.60
HMS-I3-3	10900.00	18.60		21.30		48.20
HMS-I4-1						
HMS-I4-2	11700.00	30.70	196.00	22.00		59.90
HMS-I4-3	10300.00	18.30		20.30		45.70
HMS-I4-3D	10000.00	18.70		24.70		48.40

TABLE 4-2 (CONT)

SUMMARY OF SOIL SAMPLES ABOVE BACKGROUND CRITERIA
(MEAN + 2s)

ANALYTE CONCENTRATIONS (mg/kg)

SAMPLE ID	ALUMINUM	CHROMIUM	COPPER	NICKEL	SILVER	ZINC
HMS-I5-0		15.90	37.10	8.50		40.50
HMS-I5-1	14100.00	302.00	1820.00	30.40	4.60	75.40
HMS-I5-2	17500.00	1620.00	4440.00	25.10	12.50	101.00
HMS-I5-3		18.60	42.40	10.80		
HMS-I6-0	14500.00	208.00	829.00	29.30		184.00
HMS-I6-0D	18400.00	127.00	483.00	30.00		186.00
HMS-I6-1	12400.00	22.60	29.40	18.70		37.50
HMS-I6-2	7660.00			17.10		
HMS-I6-3	14900.00	21.00		26.60		55.90
HMS-I7-0	23700.00	294.00	4630.00	23.20		113.00
HMS-I7-1		23.50	125.00			
HMS-I8-0	24300.00	40.40	82.20	26.20		81.10
HMS-J5-0	18200.00	163.00	735.00	20.00		573.00
HMS-J5-1				9.30		
HMS-J5-2				9.20		
HMS-J5-3	17300.00	28.40		31.20		58.90
HMS-J6-0	26900.00	109.00	968.00	17.90		628.00
HMS-J6-1	14000.00	24.20	26.60	19.70		55.10
HMS-J7-0	27100.00	67.30	336.00	26.90		119.00
HMS-K3-1	21200.00	43.40	120.00	41.50		66.90
HMS-K4-0		16.40	340.00	11.20		298.00
HMS-K4-0D		16.40	55.70	12.30		204.00
HMS-K4-1	13400.00	20.40		26.10		38.70
HMS-K5-0	17600.00	23.60	43.00		3.80	83.60
HMS-K6-0	24800.00	56.40	68.00	24.60	3.80	844.00
HMS-L3-0	12200.00	42.40	913.00	19.90		86.60
HMS-L3-1	17500.00	165.00	981.00	30.20		58.20
HMS-L3-1D	15400.00	917.00	2110.00	18.10		52.40
HMS-L4-0	25200.00	49.00	182.00	29.70		81.10
HMS-L5-0	25900.00	36.10	34.10	17.70		70.70
HMS-M3-0	18200.00	4420.00	3950.00	15.10		79.20
HMS-M4-0	21900.00	105.00	5010.00	17.40		81.00
HMS-OG1-0	11100.00	18.80		14.90		34.90
HMS-OG2-0	9370.00	16.70	10.90	11.40		41.30
HMS-OG3-0			8.00	11.00		33.30
HMS-OG4-0	9770.00	18.00	13.70	12.50		55.50
HMS-RS01-0	9730.00	16.30	12.10	9.80		57.50
HMS-RS01-2	9830.00	27.00	10.50	8.40		73.60
HMS-RS01-3	12200.00	19.10	11.80	18.30		42.00
HMS-RS12-0	13300.00	18.10	15.50	24.30		55.80
HMS-RS12-3	11300.00	22.70		21.40		46.40
HMS-RS23-0	9890.00	18.00		13.20		45.20
HMS-RS23-1	10900.00	21.30		18.90		38.40
HMS-RS23-3	13800.00	24.30		24.40		52.20
HMS-RS23-3D	11900.00	19.40		24.40		48.20
HMS-RS34-0	14500.00	23.70		20.70		58.10
HMS-RS34-2	15000.00	23.70		27.70		56.20
HMS-RS34-3	11300.00	19.80		20.30		47.70
HMS-ST01-0	13900.00	27.10	13.50	10.80		65.90
HMS-ST01-3	12900.00	16.70	14.80	20.40		40.30

TABLE 4-2 (CONT)

SUMMARY OF SOIL SAMPLES ABOVE BACKGROUND CRITERIA
(MEAN + 2s)

ANALYTE CONCENTRATIONS (mg/kg)

SAMPLE ID	ALUMINUM	CHROMIUM	COPPER	NICKEL	SILVER	ZINC
HMS-ST12-0	11400.00	62.40	15.90	15.70		77.70
HMS-ST12-3	12400.00	17.80	15.30	19.60		39.80
HMS-ST23-0	8820.00	14.70	13.50	17.70		58.10
HMS-ST23-2	9930.00	14.50	15.90	20.90		38.50
HMS-ST23-3	13600.00	17.30	17.70	22.70		45.50
HMS-ST34-0	9970.00	16.10	51.80	15.50		100.00
HMS-ST34-2	17300.00	21.80	42.70	30.70		61.70
HMS-ST34-3	10500.00	17.90	12.70	17.90		39.10
HMS-WV01-0		74.50	285.00	9.60		45.10
HMS-WV01-1				8.90		28.70
HMS-WV01-2	9410.00	16.90	12.80	15.20		28.90
HMS-WV01-3	13800.00	24.40	9.00	30.00		55.80
HMS-XW01-0		12.50	43.70	11.90		77.10
HMS-XW01-1		17.60	35.30	11.30		47.40
HMS-XW01-2		12.30		14.20		
HMS-XW01-3	13900.00	24.50		29.90		60.70
HMS-XW12-1	15500.00	39.70	119.00	18.70		63.50
HMS-XW12-2	7760.00	42.00	130.00	12.40		38.30
HMS-XW12-3	14500.00	24.60	13.90	28.20		53.10
HMS-YX01-0			54.20	10.20		78.70
HMS-YX01-1			8.40	8.70		40.00
HMS-YX01-2				13.60		
HMS-YX01-3	14500.00	21.00	17.70	29.60		49.70
HMS-YX12-2	18300.00	38.90	135.00	23.60		46.90
HMS-YX12-3D	12000.00	21.70	10.60	28.70		54.90
HMS-ZY01-0			12.70	9.80		31.00
HMS-ZY01-1			10.90	11.30		40.30
HMS-ZY01-2		12.90	17.90	12.30		
HMS-ZY01-3	13600.00	19.20	20.20	29.00		51.00
HMS-ZY12-0			9.10			37.00
HMS-ZY12-1				9.60		38.30
HMS-ZY12-2	9210.00	19.60	162.00	19.90		39.20
HMS-ZY12-3	14500.00	25.50		30.60		55.60

Figure 4-2. **Isoconcentration Map of Copper Concentrations in Clay Interface Soil Samples**

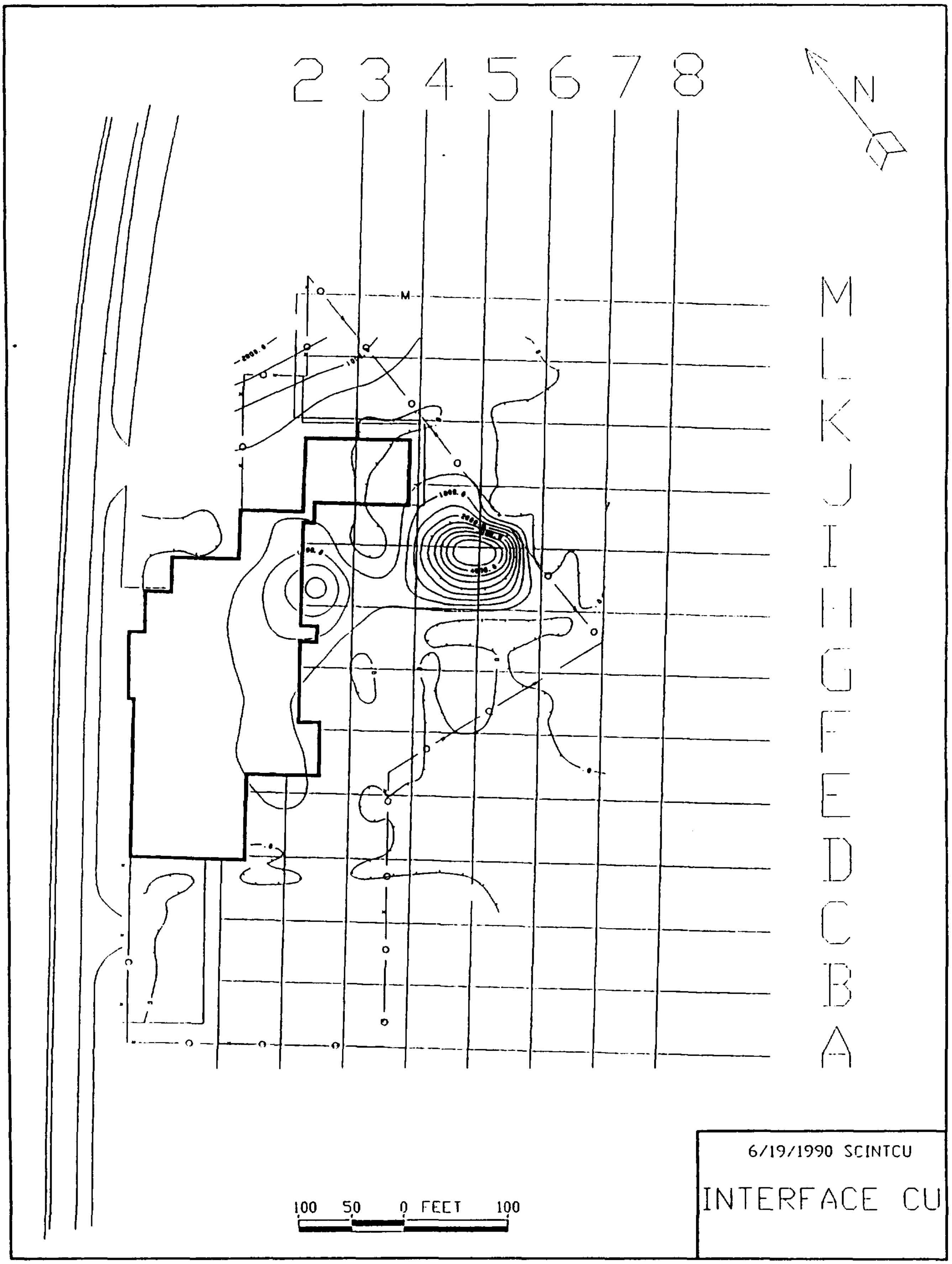


Figure 4-3. Isoconcentration Map of Chromium Concentrations in Surface Soil Samples

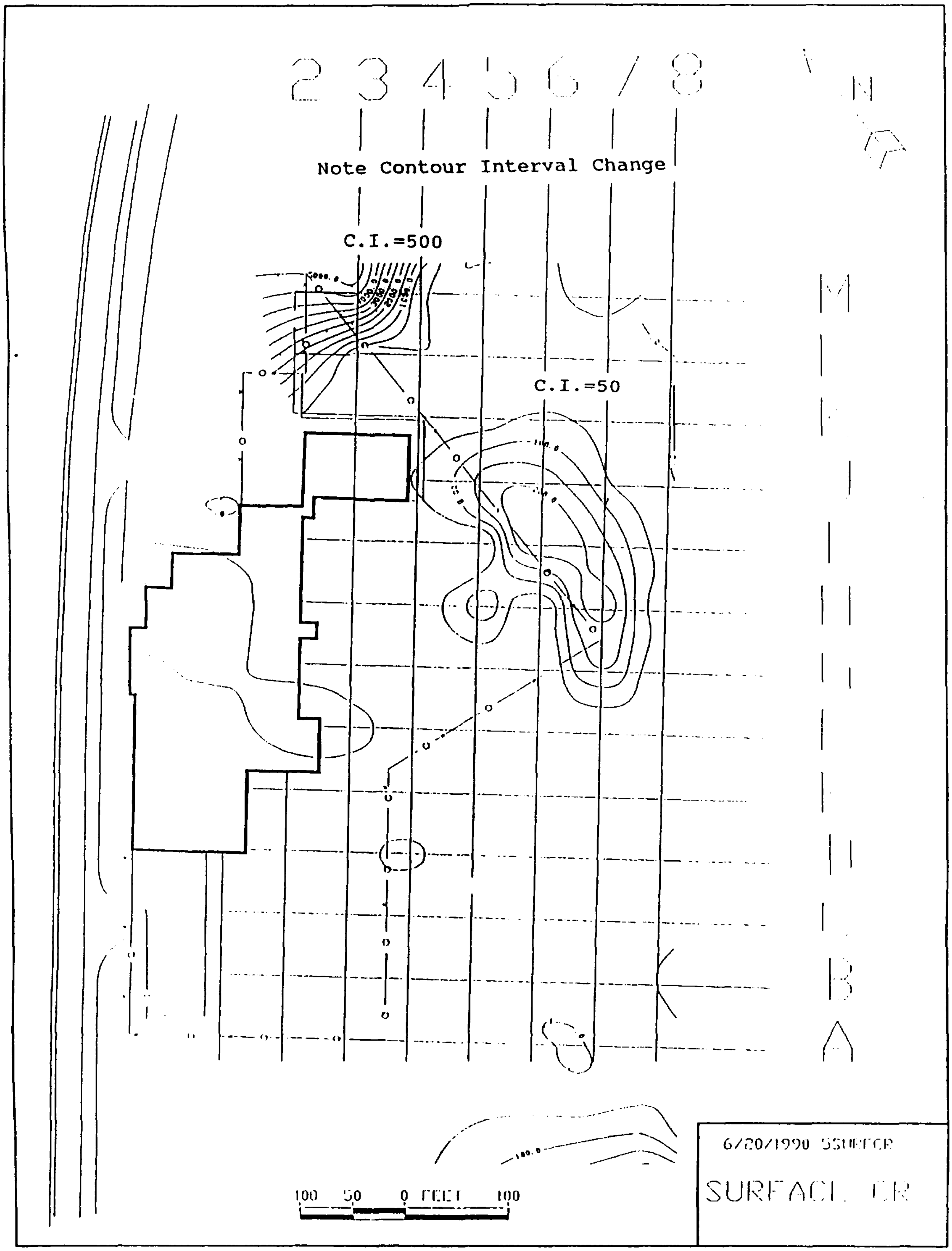


Table 4-1 shows that for nickel; the mean background concentration is 11.26 mg/kg, the highest background concentration is 50.2 mg/kg and that the BC is 43.1 mg/kg. No locations (except for background location BG-4-1) are above 43.1 mg/kg.

Table 4-1 shows that for silver; the mean background concentration is 2.27 mg/kg, the highest background concentration is 2.4 mg/kg and that the BC is 2.51 mg/kg. The highest concentration is 3.80 mg/kg in K6-0. All analyses results have UN flags except L4-0 which only has a U flag.

TAL Inorganics

The identification of contaminants of concern was based on presence at concentrations above background criteria (BC). The background criteria was determined from the chemical analysis data from the representative background samples collected during the RI. A preliminary evaluation of the analysis data for the ten (10) background samples indicated that both samples collected at BG2 and one sample collected (BG4-1) at BG4 were not representative because the concentrations of several metals were clearly higher than the general trend observed in all other samples. BG2, being proximate to the manufacturing building, is assumed to have been impacted by site activities. The sample from BG4-1, while not proximate to site activities, was observed in the laboratory to have significantly different soils characteristics when compared to the other samples. The analysis data from these three (3) apparently non-representative samples were omitted from all background calculations.

Analysis data from the seven (7) representative samples were used to determine the BC. The BC was established as the mean, at the 95% confidence interval (mean value plus two (2) standard deviations) of all measurements for a given analyte. When the analysis results were reported as below detection limit (U flag), the value of the detection limit and zero (0) were alternated in the mean calculation. In other words, the detection limit value was used for the first "U" flagged result encountered, zero (0) was entered for the next "U" flagged value, the detection limit value was used for the next "U" flagged result encountered, etc. The results from foreground sample analyses were then compared to the BC to determine which contaminants were present at elevated levels. This data then revealed the contaminants of concern and the extent of contamination.

Table 4-3 shows the mean background concentrations and background criteria for each of the 24 target analytes at 9 sample locations. All measurements of Sb, Hg, Se, Ag, Na, Tl, and CN were less than or equal to the respective background criteria. As, Be, Cd and Mn have two or less excedances above their respective background criteria.

Lead has three excedances above the BC level. These are concentrations of 60.0 mg/kg (G7-0), 22.5 mg/kg (I4-2) and 21.1 mg/kg (C4), which exceed 16.82 mg/kg (BC).

Barium, calcium, iron magnesium, potassium and vanadium and previously discussed short list metals had more than three excedances above their respective BC.

Vanadium, barium, iron and aluminum concentrations appear to vary in a related manner. No clear relationship is obvious for the other potentially elevated analytes.

4.1.2 TCL Volatile Organics

Samples for TCL volatile organic analyses in soils were obtained at I4-2 and G4-2 and within the RST-01234 and VWXYZ-012 grids, as shown on Figure 2-3. All TCL volatile organic detections are shown in Appendix J. Detections of TCL volatile organics without B, J or BJ flags are presented in Table 4-4.

Acetone, methylene chloride, and toluene were detected in I4-2 at concentrations of 0.015, 0.006 and 0.007 mg/kg, respectively. Methylene chloride, toluene and trichloroethene were detected in G4-2 with B and J flags. No other volatile organic compounds were detected outside of the RST-01234 and VWXYZ-012 grids.

The RST-01234 grid had unflagged volatile organic compounds detected in samples from all 8 sample points. Volatile organic compounds detected were methylene chloride, toluene, acetone, xylene (total), trichloroethene, 1,2-dichloroethene (total), 1,1,1-trichloroethane, ethylbenzene, chlorobenzene, and 2-butanone. Methylene chloride, toluene, xylene, ethylbenzene and 2-butanone are only reported in analyses with B, J, or BJ flags. The number of unflagged detections per compound were: trichloroethene, 10; 1,2 dichloroethene (total) 4; 1,1,1 trichloroethane 2; chlorobenzene, 1; and acetone, 1. Volatile organic compounds reported present without B, J or BJ flags with highest concentrations in parentheses were: trichloroethene (0.350 mg/kg), 1,2

TABLE 4-3

SUMMARY OF SOIL BACKGROUND CONCENTRATIONS AND STATISTICS
FOR TAL INORGANICS

SAMPLE ID	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLIUM	CADMIUM	CALCIUM	CHROMIUM
	ANALYTE CONCENTRATIONS (mg/kg)							
HMS-BG1-0	4330.00	13.10U	2.20	26.10	0.26U	0.71	342.00	7.50
HMS-BG1-0D	4850.00	13.10U	1.90	36.10	0.26U	0.72	417.00	6.60
HMS-BG2-0	16000.00	14.60U	4.90	116.00	0.70	1.90	18100.00	224.00
HMS-BG2-1	9980.00	11.70U	4.20	34.30	0.29	0.64	7460.00	15.00
HMS-BG3-0	4760.00	13.40U	1.70	18.90	0.26U	0.53U	454.00	8.00
HMS-BG4-0	6710.00	12.80U	2.70	27.80	0.25U	0.50U	1010.00	12.60
HMS-BG4-1	26400.00	13.00U	8.20	130.00	1.20	1.20	4360.00	45.20
HMS-BG5-0	3950.00	13.70U	4.80	33.40	0.27U	0.66	786.00	7.80
HMS-BG5-1	3900.00	11.70U	3.30	9.60U	0.23U	0.46U	304.00U	8.00
HMS-BG6-1	6330.00	11.70U	3.90	18.60	0.23U	1.10	857.00	9.50
	STATISTICAL ANALYSIS							
MEAN	4976	7.41	2.93	24.36	0.15	0.60	595.71	8.57
STANDARD DEVIATION	1120	6.96	1.14	9.27	0.14	0.33	282.14	1.97
MEAN + 2 STD	7216	21.34	5.21	42.9	0.43	1.23	1159.98	12.52

U = SAMPLE WAS ANALYZED, BUT NOT DETECTED

TABLE 4-3 (CONT)

SUMMARY OF BACKGROUND CONCENTRATIONS AND STATISTICS
FOR TAL INORGANICS

ANALYTE CONCENTRATIONS (mg/kg)

SAMPLE ID	COBALT	COPPER	IRON	LEAD	MAGNESIUM	MANGANESE	MERCURY	NICKEL
HMS-BG1-0	3.60U	3.00	5260.00	12.90	617.00	222.00	0.10U	5.40
HMS-BG1-0D	8.00	5.00	6030.00	13.90	671.00	617.00	0.11U	2.80U
HMS-BG2-0	11.30	892.00	12900.00	251.00	5240.00	154.00	0.22	20.30
HMS-BG2-1	5.50	17.10	13400.00	9.00	2740.00	98.70	0.09U	8.80
HMS-BG3-0	3.70U	5.80	6250.00	16.60	752.00	80.30	0.12U	4.90
HMS-BG4-0	6.20	2.50U	9210.00	11.80	1730.00	132.00	0.10U	6.00
HMS-BG4-1	14.80	7.50	43300.00	14.90	8200.00	619.00	0.12U	50.20
HMS-BG5-0	3.70U	2.70U	8500.00	11.10	1020.00	337.00	0.11U	6.00
HMS-BG5-1	3.20U	2.30U	7370.00	3.90	713.00	147.00	0.10U	2.50U
HMS-BG6-1	3.20U	6.40	10200.00	5.90	1390.00	210.00	0.11U	3.80
STATISTICAL ANALYSIS								
MEAN	2.66	3.57	7545	10.87	984.71	249.33	.05	4.49
STANDARD DEVIATION	2.96	2.27	1823.8	4.48	924.77	181.65	.06	1.46
MEAN + 2 STD	8.56	8.11	1192.59	19.83	1834.25	612.62	.17	7.42

U = COMPOUND WAS ANALYZED, BUT NOT DETECTED.

TABLE 4-3 (CONT)

SUMMARY OF SOIL BACKGROUND CONCENTRATIONS AND STATISTICS
FOR TAL INORGANICS

ANALYTE CONCENTRATIONS (mg/kg)

SAMPLE ID	POTASSIUM	SELENIUM	SILVER	SODIUM	THALLIUM	VANADIUM	ZINC	CYANIDE
HMS-BG1-0	203.00U	0.26U	2.30U	278.00U	1.00U	8.10	24.40	0.64U
HMS-BG1-0D	203.00U	0.26U	2.30U	279.00U	1.00U	7.50	26.60	0.65U
HMS-BG2-0	989.00	0.34	2.60U	310.00U	1.10U	26.80	100.00	0.72U
HMS-BG2-1	561.00	0.23U	2.10U	249.00U	0.92U	21.00	39.00	0.57U
HMS-BG3-0	207.00U	0.26U	2.40U	285.00U	1.10U	11.60	27.80	0.66U
HMS-BG4-0	733.00	0.40	2.30U	290.00	1.00U	11.10	20.90	0.63U
HMS-BG4-1	3350.00	0.26U	2.30U	288.00	1.00U	51.80	70.20	0.64U
HMS-BG5-0	368.00	0.27U	2.40U	290.00	1.10U	6.90	22.90	0.67U
HMS-BG5-1	289.00	0.23U	2.10U	248.00U	0.91U	12.40	22.40	0.57U
HMS-BG6-1	342.00	0.28	2.10U	249.00U	0.92U	16.60	23.50	0.57U

STATISITCAL ANALYSIS

MEAN	306.0	0.20	.96	199.0	0.59	10.6	24.07	.26
STANDARD DEVIATION	224.28	0.15	1.20	136.66	0.55	3.42	2.41	.33
MEAN + 2 STD	754.56	0.5	3.35	472.33	1.70	17.43	28.89	.92

U = COMPOUND WAS ANALYZED, BUT NOT DETECTED.

TABLE 4-4

SUMMARY OF TCL VOLATILE ORGANIC ANALYSIS RESULTS FOR SOIL SAMPLES (SPECIES DETECTED WITHOUT B, J, OR BJ FLAGS)

SAMPLE ID	COMPOUND	CONCENTRATION (mg/kg)
HMS-I4-2	Acetone	0.015
HMS-I4-2 RE	Toluene	0.007
HMS-I4-2 RE	Methylene chloride	0.006
HMS-RS01-0	Trichloroethene	0.007
HMS-RS01-3	Trichloroethene	0.007
HMS-RS12-3	1,2-Dichloroethene (Total)	0.015
HMS-RS23-0	Trichloroethene	0.028
HMS-RS23-1	Chlorobenzene	0.014
HMS-RS34-0	1,1,1-Trichloroethane	0.140
HMS-RS34-0	Trichloroethene	0.043
HMS-RS34-2	1,1,1-Trichloroethane	0.011
HMS-RS34-2	Trichloroethene	0.007
HMS-ST01-0	Trichloroethene	0.007
HMS-ST01-3	Trichloroethene	0.350
HMS-ST01-3	1,2-Dichloroethene (Total)	0.036
HMS-ST01-3 DL	Trichloroethene	0.210
HMS-ST12-3	1,2-Dichloroethene (Total)	0.013
HMS-ST12-3	Trichloroethene	0.012
HMS-ST23-0	Trichloroethene	0.022
HMS-ST23-3	1,2-Dichloroethene (Total)	0.041
HMS-ST34-0 RE	Acetone	0.086
HMS-WV01-2	Trichloroethene	0.240
HMS-WV01-2	1,2-Dichloroethene (Total)	0.130
HMS-WV01-2 DL	Trichloroethene	0.100
HMS-WV01-3	Trichloroethene	5.700
HMS-WV01-3	1,2-Dichloroethene (Total)	0.098
HMS-WV01-3 DL	Trichloroethene	57.000
HMS-WV01-3D	Trichloroethene	6.400
HMS-WV01-3D	1,2-Dichloroethene (Total)	0.140
HMS-WV01-3D DL	Trichloroethene	45.000
HMS-XW01-3	1,2-Dichloroethene (Total)	0.009
HMS-XW12-1	Trichloroethene	0.029
HMS-YW12-3	Acetone	0.054
HMS-YX01-3	Toluene	0.008
HMS-YX12-2	Trichloroethene	0.022
HMS-YX12-3 RE	Toluene	0.015
HMS-YX12-3 RE	Trichloroethene	0.080
HMS-YX12-3 RE	Methylene chloride	0.012
HMS-YX12-3 RE	Acetone	0.065
HMS-ZY01-3	1,2-Dichloroethene (Total)	0.010
HMS-ZY01-3	Toluene	0.012
HMS-ZY01-3 RE	Toluene	0.007
HMS-ZY12-0	Trichloroethene	0.032
HMS-ZY12-1	Trichloroethene	0.041
HMS-ZY12-1D	Trichloroethene	0.028
HMS-ZY12-1D RE	Trichloroethene	0.009
HMS-ZY12-2	Trichloroethene	0.008
HMS-ZY12-3	Trichloroethene	0.018

dichloroethene (0.041 mg/kg), 1,1,1-trichloroethane (0.140 mg/kg), chlorobenzene (0.014 mg/kg) and acetone (0.086 mg/kg).

Unflagged volatile organic compounds were detected at five of seven locations in the VWXYZ-012 grid. The following volatile organic compounds were detected: trichloroethene, 1,2- dichloroethene (total), acetone, methylene chloride, toluene, 2-butanone, 1,1,1-trichloroethane, 1,1,2,2-tetrachloroethane, 1,1,2 trichloroethane, and chlorobenzene. Chlorobenzene, 2-butanone, 1,1,1-trichloroethane, 1,1,2,2-tetrachloroethane, and 1,1,2-trichloroethane are only reported in analyses with B, J, or BJ flags. The number of unflagged detections for each compound was: trichloroethene, 15; 1,2-dichloroethene (total), 5; acetone, 2; methylene chloride 1; and toluene 3. The following volatile organic compounds (with highest concentration in parentheses) were detected without J, B, or JB flags: trichloroethene (57 mg/kg), 1,2-dichloroethene (total) (0.140 mg/kg), acetone (0.065 mg/kg), methylene chloride (0.012 mg/kg) and toluene (0.015 mg/kg).

4.1.3 TCL Organics

Reported detections for extractable (BNA), PCB and pesticide fractions are presented in Table 4-5 for both background and non-background locations. Compounds detected in both background and non-background locations were di-n-butylphthlalate; and bis(2-ethlylhexyl)phthalate. Samples detected only in background were dibenz(a,h)anthracene; benzo(b)fluoranthene; fluoranthene; benzo(a)pyrene; indeno(1,2,3-cd)pyrene; butyl benzyl phthalate; benzo(a)anthracene; benzo(g,h,i)perylene; chrysene; phenanthrene; and pyrene. No compounds were detected in non-background locations without J flags.

The only TCL organic compound (excluding volatile organic compounds discussed above) detected without B, J or BJ flags in any sample was bis(2-ethylhexyl)phthalate in one background sample. Reported background levels were 0.590 mg/kg.

4.2 Groundwater

A groundwater master data table is presented as Appendix D. The groundwater master data table includes sample ID, ENCOTEC laboratory ID number, partial descriptions of aquifer type, bottom

TABLE 4-5

SUMMARY OF TCL ORGANICS ANALYSIS RESULTS FOR SOIL SAMPLES
SPECIES DETECTED

SAMPLE ID	COMPOUND	CONCENTRAION (mg/kg)
HMS-YX12-2	bis(2-Ethylhexyl) phthalate	0.210J
HMS-I04-2	bis(2-Ethylhexyl) phthalate	0.290J
HMS-I04-2	di-n-Butyl phthalate	0.120J

of screen depth, sample collection date, project east location coordinate, project north location coordinate, top of screen elevation, and sample type.

4.2.1 Inorganics

Analyses of groundwater for dissolved TAL inorganics was performed on samples from shallow wells SW-2, SW-5, SW-8 and SW-22 and intermediate wells IW-1, IW-3 and IW-5. Analyses for dissolved short list metals were performed on samples from all shallow wells, intermediate wells, deep wells and in the pre-existing shallow wells EW-1, EW-2, EW-4 and EW-6.

A summary table of analytical results for TAL inorganic analyses of groundwater is presented in Appendix K, and a summary of short list metal analysis results is presented in Appendix L. A summary table of ammonia and nitrate/nitrite analysis results is presented as Appendix M.

Short List Metals

Short list metals in groundwater were reported in the following ranges of concentrations: aluminum, from below the detection limit of 85 μg/l to a maximum concentration of 648 μg/l (SW-20); chromium, from below the detection limit of 7 μg/l to a maximum concentration of 45.8 μg/l (SW-15); copper, from below the detection limit of 10.0 μg/l to a maximum concentration of 98.7 μg/l SW-7; nickel, from below the detection limit of 11.0 μg/l to a maximum concentration of 149.0* μg/l (SW-15); silver, from below the detection limit of 9.0 μg/l to a maximum concentration of 14.6N μg/l (SW-20); and zinc, from below the detection limit of 5.0 μg/l to a maximum concentration of 22.0 μg/l (SW-7). All detections of short list metals in groundwater without U, B, and/or N flags are presented in Table 4-6.

TAL Inorganics

TAL inorganics in groundwater were reported in the following ranges of concentrations: aluminum from below the detection limit of 85.00 μg/l to a maximum concentration of 208 μg/l (SW-22); antimony, from below the detection limits of 51.0 μg/l to 56.0 μg/l; arsenic, all were below the detection limit of 3.0 μg/l; barium, from below the detection limit of 23.0 μg/l to a maximum

TABLE 4-6

SUMMARY OF SHORT LIST METALS ANALYSIS RESULTS FOR GROUNDWATER SAMPLES
(SPECIES DETECTED WITHOUT U, B AND/OR N FLAGS)

ANALYTE CONCENTRATIONS (ug/l)

SAMPLE ID	ALUMINUM	CHROMIUM	COPPER	NICKEL	SILVER	ZINC
HMW-DW01						
HMW-DW02						
HMW-DW02-D						
HMW-DW03						
HMW-EW01						
HMW-EW02						
HMW-EW02-D						
HMW-EW04						
HMW-EW04-FB						
HMW-EW06						
HMW-EW06-FB						
HMW-IW01		20.70				
HMW-IW02						
HMW-IW03		16.00				
HMW-IW04						
HMW-IW05						
HMW-SW01						
HMW-SW02		30.20				
HMW-SW02		30.20				
HMW-SW03						
HMW-SW04						
HMW-SW05		21.10				
HMW-SW05		21.10				
HMW-SW06						
HMW-SW06-FB						
HMW-SW07			93.30			22.20
HMW-SW07-D			98.70			
HMW-SW08		12.80				
HMW-SW08		12.80				
HMW-SW08-D		15.10				
HMW-SW08-D		15.10				
HMW-SW08-FB		21.90			10.90	
HMW-SW08-FB		21.90			10.90	
HMW-SW09A						
HMW-SW09A-FB						
HMW-SW10			33.80			
HMW-SW11				129.00		
HMW-SW12						
HMW-SW14						
HMW-SW15		45.80		149.00		
HMW-SW17						
HMW-SW18						
HMW-SW19				119.00		
HMW-SW20	648.00			131.00		22.10
HMW-SW21						
HMW-SW22	208.00					
HMW-SW22	208.00					

concentration of 59.10B μg/l in SW-8D; beryllium, from below the detection limits of 1.00 μg/l to 2.00 μg/l; cadmium, all were below detection limit of 2.00 μg/l; calcium, from a minimum concentration of 59,000 μg/l (SW-2) to a maximum concentration of 305,000 μg/l (SW-8); chromium, from the detection limit of 9.0 μg/l to a maximum concentration of 30.20* μg/l (SW-2); cobalt, from below the detection limits of 9.0 μg/l to 14.0 μg/l; copper, from below the detection limits of 10.0μg/l to 11.0 μg/l; iron, from below the detection limit of 29.00 μg/l to a maximum concentration of 391.00 μg/l (IW-3); lead, from below the detection limit of 2.00 μg/l to a maximum concentration of 2.20B μg/l; magnesium, from a minimum concentration of 18,000 μg/l (IW-3) to a maximum concentration of 529,000 μg/l in SW-22; manganese, from a minimum concentration of 49.2 μg/l (IW-5) to a maximum concentration of 811.00 μg/l (SW-5); mercury, all were below the detection limit of 0.20 μg/l; nickel, from below the detection limit of 11.00 μg/l to a maximum concentration of 20.30B μg/l (SW-22); potassium, from a minimum concentration of 905.00B μg/l (SW-2) to a maximum concentration of 11,500 μg/l (SW-5); selenium, all were below the detection limit of 1.00 μg/l; silver, from below the detection limit of 8.00 μg/l to a maximum concentration of 10.90 μg/l (SW-8-FB); sodium, from a minimum concentration of 3,450.00B μg/l (SW-2) to a maximum concentration of 579,000 μg/l (SW-22); thallium, all samples were below the detection limit of 4.00 μg/l; vanadium, from below the detection limit of 8.00 μg/l to a maximum concentration of 1090B μg/l (IW-5); zinc, from below the detection limits of 5.00 μg/l to 6.00 μg/l; and cyanide, from below detection limit of 10.00 μg/l to a maximum concentration of 37.00 μg/l (SW-5).

Ammonia and Nitrate/Nitrite

Ammonia and nitrate/nitrite analyses were performed on groundwater from SW-1, SW-2, SW-3, SW-4, SW-5, SW-6, SW-8, SW-10, SW-11, SW-12, SW-14, SW-15, SW-17, SW-18, SW-19, SW-20, and SW-21. Ammonia concentrations ranged from below the method detection limit of 50.00 μg/l to 2200.00 μg/l in SW-22. All reported ammonia analyses had A and C flags. Nitrate plus nitrite concentrations ranged from below the method detection limit of 50.00 μg/l to 16,000 μg/l in SW-5. All reported nitrate plus nitrite analyses had A and C flags.

TABLE 4-7

SUMMARY OF ORGANIC ANALYSIS RESULTS FOR GROUNDWATER SAMPLES
(SPECIES DETECTED)

TRIP BLANK REFERENCE DATE	SAMPLE ID	COMPOUND	CONCENTRATION (mg/l)	FLAG
03/15/90	HMW-SW11	Toluene	0.003	JB
	HMW-SW11	Methylene chloride	0.005	B
	HMW-SW20	2-Butanone	0.010	B
	HMW-SW20	Toluene	0.003	JB
	HMW-SW20	Acetone	0.017	B
	HMW-SW20	Methylene chloride	0.005	B
	HMW-TB-03/15/90	2-Butanone	0.004	JB
	HMW-TB-03/15/90	Toluene	0.003	JB
	HMW-TB-03/15/90	Methylene chloride	0.011	B
	HMW-TB-03/19/90	Acetone	0.012	B
03/16/90	HMW-SW04	2-Butanone	0.015	B
	HMW-SW04	Toluene	0.003	J
	HMW-SW04	Methylene chloride	0.004	JB
	HMW-SW05	Acetone	0.027	B
	HMW-SW05	1,2-Dichloroethene (Total)	0.075	
	HMW-SW05	Vinyl chloride	0.004	J
	HMW-SW05	Methylene chloride	0.009	B
	HMW-SW05-D	Acetone	0.033	B
	HMW-SW05-D	1,2-Dichloroethene (Total)	0.068	
	HMW-SW05-D	2-Butanone	0.028	B
	HMW-SW05-D	Vinyl chloride	0.003	J
	HMW-SW05-D	Methylene chloride	0.009	B
	HMW-SW06	Acetone	0.006	JB
	HMW-SW06	2-Butanone	0.001	JB
	HMW-SW06	Methylene chloride	0.009	B
	HMW-SW06-FB	Acetone	0.017	B
	HMW-SW06-FB	2-Butanone	0.004	JB
	HMW-SW06-FB	Methylene chloride	0.009	B
	HMW-SW08	Methylene chloride	0.007	B
	HMW-TB-03/16/90	Acetone	0.011	B
	HMW-TB-03/16/90	2-Butanone	0.004	JB
	HMW-TB-03/16/90	Toluene	0.001	J
	HMW-TB-03/16/90	Methylene chloride	0.016	B
03/19/90	HMW-SW01	2-Butanone	0.090	JB
	HMW-SW01	1,2-Dichloroethene (Total)	0.360	
	HMW-SW01	Acetone	0.160	B
	HMW-SW01	Methylene chloride	0.100	B
	HMW-SW01	Trichloroethene	1.100	
	HMW-SW02	Methylene chloride	0.010	B
	HMW-SW03	2-Butanone	0.018	JB
	HMW-SW03	Vinyl chloride	0.068	
	HMW-SW03	Acetone	0.046	B
	HMW-SW03	1,2-Dichloroethene (Total)	0.180	
	HMW-SW03	Methylene chloride	0.026	B
	HMW-SW03	Trichloroethene	0.014	
	HMW-TB-03/19/90	2-Butanone	0.004	JB
	HMW-TB-03/19/90	Acetone	0.012	B
	HMW-TB-03/19/90	Trichloroethene	0.001	J

TABLE 4-7 (CONT)

SUMMARY OF ORGANIC ANALYSIS RESULTS FOR GROUNDWATER SAMPLES
(SPECIES DETECTED)

TRIP BLANK REFERENCE DATE	SAMPLE ID	COMPOUND	CONCENTRATION (mg/l)	FLAG
03/19/90	HMW-TB-03/19/90	Methylene chloride	0.012	B
03/20/90	HMW-IW01	Toluene	0.003	JB
	HMW-IW01	Methylene chloride	0.002	JB
	HMW-IW04	Acetone	0.003	JB
	HMW-IW04	Methylene chloride	0.008	B
	HMW-IW04	2-Butanone	0.005	JB
	HMW-SW10	Acetone	0.002	JB
	HMW-SW10	Methylene chloride	0.006	B
	HMW-SW10	2-Butanone	0.004	JB
	HMW-SW10	1,2-Dichloroethene (Total)	0.030	
	HMW-SW10-D	Acetone	0.015	B
	HMW-SW10-D	Methylene chloride	0.009	B
	HMW-SW10-D	1,2-Dichloroethene (Total)	0.035	
	HMW-SW12	2-Butanone	0.006	JB
	HMW-SW12	Acetone	0.011	B
	HMW-SW12	Toluene	0.003	JB
	HMW-SW12	Methylene chloride	0.002	JB
	HMW-TB-03/20/90	2-Butanone	0.004	JB
	HMW-TB-03/20/90	Methylene chloride	0.003	JB
	HMW-TB-03/20/90	Toluene	0.002	JB
	HMW-TB-03/20/90	Acetone	0.008	JB
03/21/90	HMW-DW02	Toluene	0.001	JB
	HMW-DW02	Methylene chloride	0.045	B
	HMW-DW02	Acetone	0.016	B
	HMW-DW02-FB	Methylene chloride	0.005	B
	HMW-DW02-FB	Acetone	0.029	B
	HMW-IW03	Acetone	0.018	B
	HMW-IW03	Methylene chloride	0.010	B
	HMW-TB-03/21/90	Toluene	0.001	J
	HMW-TB-03/21/90	Methylene chloride	0.012	B
	HMW-TB-03/21/90	Acetone	0.013	B
03/22/90	HMW-TB-03/22/90	Methylene chloride	0.014	B
	HMW-TB-03/22/90	Acetone	0.013	B
03/23/90	HMW-DW01	Methylene chloride	0.014	B
	HMW-DW01	2-Butanone	0.007	J
	HMW-DW01	Acetone	0.022	B
	HMW-DW03 AND MA	Methylene chloride	0.007	
	HMW-IW02	Methylene chloride	0.008	
	HMW-IW05	Methylene chloride	0.017	
	HMW-TB-03/23/90	Acetone	0.011	
	HMW-TB-03/23/90	Methylene chloride	0.014	
03/25/90	HMW-SW22	Methylene chloride	0.020	

4.2.2 TCL Volatile Organics

TCL volatile organic compounds were analyzed in groundwater samples from shallow wells SW-1, SW-2, SW-3, SW-4, SW-5, SW-6, SW-8, SW-10, SW-11, SW-12, SW-20, SW-22; intermediate wells, IW-1, IW-2, IW-3, IW-4, IW-5; and deep wells DW-1, DW-2 and DW-3. Well locations are shown on Figure 2-4. A summary table of all analytical results above detection limits is presented in Appendix J. TCL volatile organic compounds detected above the detection limits are presented in Table 4-7. The samples in which volatile organics were detected were as follows: trichloroethene, SW-1 and SW-3; 1,2 dichloroethene (total), SW-3, SW-5, SW-5D, SW-10, SW-10D, SW-10MS; vinyl chloride, SW-3; methylene chloride, DW-3, IW-2, IW-5, SW-22, SW-22D, SW-22FB, and MW-TB.The highest concentration and location are: trichloroethene (1,100 μg/l in SW-1), 1,2 dichloroethene (total) (360 μg/l in SW-1), vinyl chloride (68 μg/l in SW-3), methylene chloride (29 μg/l in SW-22FB), and acetone (11 μg/l in MW-TB).

4.2.3 TCL Organics

TCL organic analyses were performed on groundwater from SW-2, SW-2D, SW-2FB, SW-5, SW-8 and IW-1. Di-n-butyl phthalate (8 μg/l in SW-2) was the only base-neutral or acid extractable compound detected in groundwater samples. Pesticides and PCB analyses were not performed on groundwater samples.

4.3 Surface Water and Sediments

A surface water master data table is presented as Appendix A. The surface water master data table presents station, sample ID, ENCOTEC sample ID number, sample collection date, project east location coordinate, project north location coordinate, elevation and sample type for each surface water sample point.

4.3.1 Inorganics

Analyses for short list metals were performed on samples from BP-1, BP-2, BP-3, TP-1, TP-4, TP-4FB,TP-10, TP-10D, WL-1 and WL-2. TAL inorganic analyses were performed on BP-4, TP-2, TP-7, TP-7D, TP-11, TP-11D, and TP-11FB. Ammonia and nitrate plus nitrite analyses were performed on BP-1, BP-2, BP-3, BP-4, TP-7, TP-7D, TP-10, and WL-2. Hexavalent chromium analyses were performed on samples from BP-1, BP-2, BP-3, BP-4, TP-1, TP-2, TP-2FB, TP-4, TP-4DTP-7, TP-9, TP-10, TP-10D, TP-11, WL-1, and WL-2. A summary of short list metal concentrations in sediments is presented in Table 4-8.

Short List Metals

Short list metals in surface water had the following range of concentrations reported: aluminum below the detection limit of 85.00 μg/l for all samples except TP-9 (5360 μg/l); chromium, below the detection limit for all samples except TP-1 (13.00 μg/l); copper, below the detection limit for all samples except BP-1 (19.50 BN) and TP-10 (21.40); nickel, from below detection limit of 11.00* μg/l to a maximum concentration of 302.00* μg/l in TP-9; silver, from below the detection limit of 9.00 μg/l to a maximum concentration of 12.50N μg/l in BP-2; and zinc, from below the detection limit of 6.00 μg/l and a maximum concentration of 16.20B μg/l in TP-10D.

TAL Inorganics

The following TAL inorganics were below detection limits in all surface water samples (limits in parentheses): aluminum (85.00 μg/l); arsenic (3.00 μg/l); barium (42.00 μg/l); beryllium (1.00 μg/l); cadmium (2.00 μg/l); cobalt (14.00 μg/l; mercury (0.20 μg/l); nickel (11.00 μg/l); selenium (1.00 μg/l); thallium (4.00 μg/l); vanadium (8.00 μg/l); and cyanide 10.00 μg/l). Surface water samples for all locations were below background surface water station BP-4 for antimony (background, 65.40 μg/l) and zinc (background, 12.40 μg/l).

TAL inorganic concentrations for all other compounds are presented below for the background sample (BP-4), lowest sample location and highest sample location: calcium, 26500.00 μg/l (BP-4), 13,300.00 μg/l (TP-11 FB),and 44,500.00 μg/l (TP-7); chromium, 9.30* μg/l (BP-4), 7.00* μg/l (TP-2), and 38.50* μg/l (TP-11); copper, less than the detection limit of 10.00 μg/l for all samples except TP-11 (13.00B μg/l); iron, less than the detection limit (BP-4), 625.00 μg/l (TP-11); lead, 3.30 μg/l (BP-4), less than the detection limit (TP-2), and 7.80 μg/l (TP-11FB); magnesium, 5050.00 μg/l (BP-4), less than the detection limit (TP-11FB), and 11,800 μg/l (TP-7); manganese, 7.30B (BP-4), less than detection limit (TP-11FB), and 378.00 μg/l (TP-11); potassium, 817.00B μg/l (BP-4), less

FIGURE 4-8

SUMMARY OF SHORT LIST METALS CONCENTRATIONS - SEDIMENTS

ANALYTE CONCENTRATIONS (mg/kg)

SAMPLE ID	ALUMINUM	CHROMIUM	COPPER	NICKEL	SILVER	ZINC
HMS-BP01-0	1090.00	22.90B	30.30UN	33.30U	27.30UN	18.20U
HMS-BP02-0	964.00	29.80U	42.60UN	46.80U	38.30UN	25.50U
HMS-BP03-0	3530.00	20.30U	34.80B	31.90U	26.10UN	71.60
HMS-BP04-0	3610.00	37.10	28.20U	31.00U	25.40U	122.00
HMS-TP01-0	14100.00	21.90	42.20	13.90B	3.30UN	86.80
HMS-TP01-0D	13800.00	18.60	52.60	12.20	2.70UN	56.00
HMS-TP02-0	33900.00	43.20	36.90	23.30	3.50U	42.70
HMS-TP03-0	11800.00	17.30	2.80U	13.60	2.60UN	48.70
HMS-TP04-0	28400.00	145.00	429.00	41.90	4.10UN	104.00
HMS-TP04-1	11800.00	24.90	18.40	28.20	2.20UN	51.40
HMS-TP05-0	12700.00	34.80	277.00N	17.50B	4.90UN	70.60
HMS-TP06-0	21500.00	36.20	64.80	20.10	3.00UN	51.50
HMS-TP06-1	15300.00	25.40	7.00	27.80	2.20UN	52.50
HMS-TP07-0	27800.00	50.90	105.00	27.00	3.20U	82.00
HMS-TP07-1	16300.00	28.50	10.70	27.20	2.30UN	55.90
HMS-TP07-1D	13600.00	24.80	15.40	25.40	2.30UN	52.00
HMS-TP08-0	28600.00	256.00	982.00	33.10	3.10UN	208.00
HMS-TP08-1	15500.00	30.50	6.60	30.60	2.20U	53.10
HMS-TP08-1D	17300.00	32.40	6.10B	32.40	2.20U	55.10
HMS-TP09-0	12500.00	31.20	189.00N	7.30B	3.60UN	68.70
HMS-TP10-0	16700.00	36.40	77.40N	23.80	2.70UN	68.00
HMS-TP11-0	21500.00	974.00	1860.00	22.80	2.60UN	65.30
HMS-TP11-1	13800.00	32.00	15.10	22.70	2.30UN	41.10
HMS-TP12-0	16400.00	33.60	238.00	15.40	5.66UN	75.30
HMS-WL01-0	1360.00	51.80	486.00	21.80U	17.80UN	75.60
HMS-WL02-0	6770.00	7.30U	10.40U	28.10B	9.40UN	56.90

STATISTICAL ANALYSIS

MEAN	2298.5	20.5	19.35	19.45	15.93	54.78
STANDARD DEVIATION	1272.6	13.24	19.55	20.24	16.57	46.53
MEAN + 2 STD	4843.7	47.28	58.45	59.93	49.07	147.84

than the detection limit of 788.00 μg/l (TP-11FB), and 3880.00B μg/l (TP-7); silver, less than detection limit of 9.00 μg/l in all samples except TP-7 (9.10B μg/l); and sodium, 2620.00B (BP-4), less than detection limit of 1,080.00 μg/l (TP-11FB), and 26,000.00 μg/l (TP-7).

Hexavalent chromium was less than the detection limit of 10.00 μg/l at all surface water locations.

Ammonia and Nitrate/Nitrite

Ammonia analyses were performed on surface water samples from BP-1, BP-2, BP-3, BP-4, and TP-07FB. Nitrate/nitrite analyses were performed on surface water samples from BP-1, BP-2, BP-3, BP-4, TP-7, TP-7D, TP-7FB and WL-2.

Ammonia concentrations ranged from below the detection limit of 50.00 μg/l to a maximum concentration of 160.00AC μg/l (BP-1). Nitrate/nitrite concentrations ranged from below the detection limit of 50.00 μg/l to a maximum concentration of 1200.00AC μg/l in TP-7FB. The concentration in TP-7FB was considerably higher than the next highest concentration of nitrate\nitrite, 180.00AC μg/l (BP-1), which was in the background pond.

4.3.2 Sediments

The sediment master data table is presented as Appendix B. The master data table includes sample station number, sample ID number, ENCOTEC laboratory ID number, sample collection date, project east and north coordinates, elevation, and sample type for each sample. Locations of sediment sample points are shown on Figure 2-1.

Inorganics

Short list metals were analyzed at all Background Pond, Target Pond and Waterbury Lake sample locations. A summary of results for those test points that exceeded background criteria is presented in Table 4-8. Hexavalent chromium was analyzed in samples from locations BP-1, BP-2, BP-3, BP-4, TP-1,TP-4, TP-4-1, TP-5, TP-6, TP-6-1, TP-9, TP-10, WL-1, WL-2, and WL-2D.

Values for aluminum range from 964 mg/kg to 3610 mg/kg in the Background Pond, from 11,800.00 mg/kg to 33,900.00 mg/kg (TP-2) in the Target Pond, and from 1360.00 mg/kg to 6770.00 mg/kg in Waterbury Lake. All nineteen test points in the Target Wetland and one sample point in Waterbury Lake (WL-02) exceeded the BC of 4842 mg/kg.

Values for chromium range from less than detection (20.30U mg/kg) to 37.10 mg/kg in the Background Pond, from 17.30 mg/kg to 256.00 mg/kg (TP-8) in the Target Pond, and from less than detection (7.30U mg/kg) to 51.80 mg/kg in Waterbury Lake. Three test points in the Target Wetland (TP04-0, TP07-0, and TP08-0) and one point in Waterbury Lake (WL01) exceeded the BC of 50.65 mg/kg.

Values for copper range from less than detection (28.20U mg/kg) to 37.10 mg/kg in the Background Pond, from 17.30 mg/kg to 256.00 mg/kg in the Target Pond, and from less than detection (10.40U mg/kg) to 486.00 mg/kg in Waterbury Lake. Eight test points in the Target Wetland and one test point in Waterbury Lake (WL01) exceeded the BC of 54.91 mg/kg.

Values for nickel range from less than detection (31.00U mg/kg) to less than detection (46.80U mg/kg) in the Background Pond, from 7.30B mg/kg to 41.90 mg/kg (TP-04) in the Target Pond, and from less than detection (21.80U mg/kg) to 28.10B mg/kg in Waterbury Lake. None of the test points exceeded the highest detection limit of the background samples (46.8 mg/kg).

Values for silver were reported below detection limits for all samples.

Values for zinc range from 18.20U mg/kg to 122.00 mg/kg in the Background Pond, from 42.70 mg/kg to 208.00 mg/kg (TP-8) in the Target Pond, and from 56.90 mg/kg to 75.90 mg/kg in Waterbury Lake. One sample point in the Target Pond (TP08-0) exceeded the BC of 162.23 mg/kg.

Analysis results for hexavalent chromium at all sample locations were below the detection limits of 0.10 mg/kg to 2.00 mg/kg.

4.4 Summary and Conclusions

4.4.1 Soils

Based upon evaluations of the Remedial Investigation site assessment data presented in Sections 3 and 4 above, contaminated soils within the investigation area can be divided into three areas for purposes of contamination assessment, risk evaluation and remedial feasibility planning. These areas are the area between the production facility and the Target Wetland, the general vicinity of the small eastern assessment area VWXYZ-012, and the general vicinity of the small western assessment area, RST-01234.

Area Between Production Facility and Target Wetland

Soils located between the production facility and the Target Wetland were found to contain elevated levels of certain metals. This area appears to be roughly bounded by portions of the sample grid, but has not been fully defined.

TAL analytes Ag, As, Be, Cd, Pd, and Mn were all measured at levels greater than their respective BC but in three or fewer samples. These results indicate that these metals are not characteristic of significant site contamination and need not be addressed further. TAL analytes, Al, Ba, Ca, Cr, Cu, Fe, Mg, Ni, K, V and Zn were all measured at levels greater than their respective BCs in multiple samples. The most significant site wide contamination is represented by the metals Al, Cr, Cu, Ni, and Zn. There are clearly locations containing significantly elevated concentrations of these metals. However, the areal extent of contamination indicated by the number of results above BC (Table 4-2) may be significantly overstated for these five metals. This statement is based upon a evaluation of the step-shaped distribution of concentrations in foreground samples. For each metal there is a large cluster of results which indicate slight elevation above the BC. There is no basis to assume that the selected background locations include all naturally occurring soil types. This may have resulted in a negative bias in the BC, making the number of excedences unreasonably high.

Chromium and copper appear to be reasonable indicators for the extent of metals contamination. The highest levels of contamination were generally found at or above the soil clay interface. The clay layer appears to be a barrier to downward migration. The locations of highest concentrations generally lie near and immediately southeast of the former lagoons and in the vicinity of grid location L3, L4, M3, and M4. Samples from these areas were organic rich clay. In the soil interface samples, sample I-5 described as a peat, had the highest copper concentration. These data suggest a possible correlation between organic content and contaminant metal concentrations.

Grid Area VWXYZ-012

The TAL species Al. Ba. Ca, Cr, Cu, Fe, Mg, Ni, K, V and Zn were measured in concentrations above their respective BCs. Copper appears to be a reasonable indicator for metals contamination in this area. The highest levels of contamination were generally found at or above the soil clay interface. The clay layer appears to be a barrier to downward migration of metals.

The TCL volatile specie toluene was measured in two samples at concentrations of 8 μg/kg and 12 μg/kg. Since these values are only slightly elevated above CRDL, and toluene was not detected without flags in any other site soil sample, toluene is not considered a significant of concern. No other TCL organic species were detected without flags in this area.

Grid Area RST-01234

The TAL species Al, Cr, Cu, Ni and Zn were measured in concentrations above their respective BCs. However, greater than 95% of these values are in the cluster of measurements which are slightly elevated above BC. The highest levels of contamination were generally found at or above the soil clay interface. The clay layer appears to be a barrier to downward migration of metals.

The TCL volatile species trichloroethene, 1,1,1-trichloroethane and/or chlorobenzene were measured in nine samples from this area. Chlorobenzene was detected in only one sample (14 μg/kg) collected during the Remedial Investigation; therefore it is reasonable to assume that this detection is an artifact or an isolated detection. Chlorobenzene is not considered a contaminant of concern within this grid or at the site. The other two volatile organic compounds were measured at concentrations between 7 μg/kg and 350 μg/kg.

4.4.2 Groundwater

Groundwater investigations were divided into three zones, shallow, intermediate and deep. Remedial Investigation data presented in Sections 3 and 4 of this report confirm that these are distinct zones as evidenced by the presence of clay layers, variability in flow direction and gradient, and differences in hydraulic potential. Therefore, it is appropriate to continue discussion of groundwater in terms of three distinct zones.

Shallow Saturated Zone

The TAL species detected in shallow groundwater were Al, Ag, Ca, Cr, Cu. Fe, Mg, Mn, K, Na, and Zn. Al, Ca, Fe, Mg, Mn K and Na are commonly occurring cations in groundwater. Since no groundwater background location has been established, there is no basis for identifying these species as contaminants at this time. However, based upon evaluations of general concentration trends, SW-5 has levels of Na, Mn, Ca, and K that may be significantly elevated; SW-8 has levels of Na, Mg, Mn, and Ca that may be significantly elevated; SW-20 has an aluminum level that may be significantly elevated; and SW-22 has levels of Al, Mg and Ca that may be significantly elevated.

Silver was only detected in SW-20, east of the Target Wetland. The groundwater flow direction in the shallow aquifer and the absence of silver in any other water sample indicates that the silver detected in SW-20 is not related to the Hi-Mill site. However, groundwater flow direction in the vicinity of SW-20 indicates that potential sources of this species would be toward the east, in the general vicinity of Numatics, Inc.

Chromium was the most frequently detected metal in the shallow aquifer. It was measured at elevated levels in three shallow wells between the production building and the Target Pond and in SW-15 southwest of the Target Pond. Copper was only detected in two wells, located between the production building and the Target Pond. Zinc was detected in two wells, one located between the production building and the Target Pond and one (SW-20) located east of the Target Wetland. The groundwater flow direction in the shallow aquifer indicates that the zinc detected in SW-20 is not related to the Hi-Mill site. However, groundwater flow direction in the vicinity of SW-20 indicates that potential sources of this species would be toward the east, in the general vicinity of Numatics, Inc. These results indicate that contamination of the shallow zone of saturation is generally confined to the area between the production facility and the Target Pond.

Several TCL volatile organics were detected in shallow monitor wells; however, no extractable TCL organic species were measured. Based upon the types of chemicals used at the Hi-Mill site, chemical analysis flags, identification of common laboratory artifacts, and the infrequent detection, the following species were eliminated from consideration as potentially significant contaminants: methylene chloride, acetone, toluene, and 2-butanone. Trichloroethene, 1,2-dichloroethene (total), and vinyl chloride are considered potentially significant contaminants based upon concentrations and frequency of detections. These contaminants were detected in five wells, and their distribution appears consistent with the direction of groundwater flow and known areas of chemical use or handling. Sampling and analysis of additional shallow wells for TCL volatile organics has been recommended in the Technical Memorandum for the planned confirmatory groundwater sampling event to further identify the extent of this contamination.

Intermediate Aquifer

The TAL species detected in groundwater samples from monitor wells in the intermediate aquifer were Ba, Ca, Cr, Fe, Mg, Mn, K, Na and V. Ba, Ca, Fe, Mg, Mn, K and Na are commonly occurring cations in groundwater. Since no groundwater background location has been established, there is no basis for identifying these species as contaminants at this time. Chromium was identified in IW-1 and IW-3, both of which appear to be hydraulicly downgradient of the Hi-Mill former lagoons. Vanadium was only detected in IW-5 and is not thought to be a contaminant of concern based upon its absence in the shallow aquifer and the fact that IW-5 appears to hydraulically upgradient of the Hi-Mill facility.

Four TCL volatile organic species (toluene, methylene chloride, acetone, and 2-butanone) were detected in samples from the intermediate aquifer. Based upon the types of chemicals used at the Hi-Mill site, chemical analysis flags, identification of common laboratory artifacts, and the infrequent detection, all of these species were eliminated from consideration as potentially significant contaminants.

Deep Aquifer

No TAL inorganics contaminants of concern were detected in samples from the deep aquifer. Several TCL volatile organic species (toluene, methylene chloride, acetone, and 2-butanone) were detected in samples from the deep aquifer. Based upon the types of chemicals used at the Hi-M i l l site, chemical analysis flags, identification of common laboratory artifacts, and the infrequent detection, all of these species were eliminated from consideration as potentially significant contaminants.

Surface Water and Sediments

The TAL short list metal species detected in surface water were Al and Cr. Hexavalent chromium was not detected in any surface water sample; therefore, the chromium detected in surface water was trivalent. Aluminum was only detected at TP-9. Chromium was only detected at TP-1. These sample points are north of M-59 and in the southernmost end of the Target Wetland, respectively. These data indicate that metals contamination of surface waters near the Hi-Mill site is not of concern.

The TAL short list metals species detected in sediments were Al, Cr, Cu, and Zn. Hexavalent chromium was not detected in any sediment samples. Aluminum was found to be elevated in all sediment samples collected from the Target Wetland and slightly elevated in one sample from Waterbury Lake (WL-02).

Elevated levels of chromium in the Target Pond were found in samples collected from the uppermost sediment layer along the shore nearest the Hi-Mill facility (TP-4, TP-7, and TP-8). Elevated levels of chromium were also found in one sample collected at TP-2 in an isolated wet area near Numatics, Inc. Samples from underlying sediments were found to not contain chromium at elevated levels, thus indicating that there is rapid attenuation of concentration with respect to sediment depth. Slightly elevated levels of chromium was detected in Waterbury Lake (WL-1). Since hexavalent chromium was not detected in sediment samples, all elevated chromium levels in sediments are trivalent chromium.

Elevated levels of copper in the Target Wetland were found in the shallow sediments at eight sample points (TP-4, TP-5, TP-6, TP-7, TP-8, TP-9, TP-10 and TP-12). These points are evenly distributed across the Target Wetland. Samples from underlying sediments were found to not contain copper at elevated levels, thus indicating that there is rapid attenuation of concentration with respect to sediment depth. Elevated copper was also measured in one sample (WL-01) from Waterbury Lake.

Zinc was found to be slightly elevated in only one shallow sediment sample (TP-8). This single data point is insufficient to make zinc a contaminant of concern in the Target Wetland.

The three detections of elevated metals in sediments of Waterbury Lake were aluminum at WL-02, chromium at and copper at WL-01. Aluminum and chromium are only slightly elevated. WL-2 is in the isolated northern arm of Waterbury Lake. Therefore, there is insufficient evidence to indicate that any contaminants of concern are present in the main body Waterbury Lake.

5.0 CONTAMINANT FATE AND TRANSPORT

5.1 Potential Routes of Migration

Potential routes of migration include routes for both translocation within a given media type or transfer between media types. Potential migration routes within soils are expected to require either actual translocation of soil particles or transfer from either air or water. Soil particle translocation can occur as a result of the action of wind, surface water, and human or animal activities. Only potential human activities are considered significant. Surfaces are generally vegetated and no indication of wind erosion or transport was observed during the Remedial Investigation. It is possible that volatile species could be transported in the vapor phase through subsurface soils. Vapor transport is expected to be driven primarily by diffusion or density. Surface water drainages are poorly developed at the site and all site soils are considered to have poor runoff. Therefore, the potential for soils transport by surface water is considered minimal. No indication of large burrowing animals were observed during the Remedial Investigation, however, several large ant hills were noted during the Remedial Investigation. Contaminant migration, as a result of soil particle translocation, is expected to be minimal unless related to hypothetical human activities.

Groundwater is a potential route for contaminant migration. All species detected in groundwater are expected to be transported in the general direction of groundwater flow at a rate equal or less than the rate of groundwater movement. Retardation of dissolved species may be significant for both metals and volatile organic compounds. Soluble species in other media may reach groundwater via infiltration and subsequently be mobilized with groundwater. Fluctuations of shallow groundwater levels may result in the dissolution of soluble species present in soils within the zone of fluctuation. soil. Groundwater is in direct communication with surface water in the Target Wetland and probably with surface water in Waterbury Lake, and may contribute dissolved species to either surface water or sediments. However, groundwater transport typically results in concentrations that are lower than the concentrations present in the groundwater.

Surface water bodies within the study area have no external drainage except for the small wetland across from Waterbury Lake and north of M-59. Surface runoff within the study area is generally limited. Small drainages are present south and west of the Hi-Mill fence. These were sampled during the Remedial Investigation as they have the potential to be routes of transport for dissolved species. Surface water within the wetlands may leach soluble species from sediments or soils which may then be translocated through either advection or dispersion.

5.2 Contaminant Persistence

Five metals (aluminum, chromium, copper, nickel and zinc) and four volatile organic compounds (trichloroethene, 1,2-dichloroethene, vinyl chloride and 1,1,1-trichloroethane) have been identified as potential contaminants of concern. Contaminant persistence for these metals and volatile organics are discussed below.

The metals of concern are expected to persist unless dissolved and transported by water. The extent or rate of this dissolution and transport in not known at the Hi-Mill site. Metals may be immobilized in soils as a result of fixation within soil minerals or adsorption onto soil surfaces. Fixation reactions may involve chemisosorption, solid state diffusion or precipitation of minerals. Adsorption by cation adsorption, often associated with organic materials, is known to occur for all five metals of concern. The Soil Chemistry of Hazardous Materials by James Dragun reports the observed range of adsorption coefficients (Kd) for three of these five metals. The adsorption coefficient ranges (mg/l) are as follows: trivalent chromium (470 to 150,000); copper (1.4 to 333); and zinc (0.1 to 8,000). Element mobility in soils may vary over a wide range and is controlled by soil physical and chemical properties.

The four volatile organic compounds of concern are not expected to persist in the environment due to volatilization and degradation. Microbes are known to be able to strip chlorines from three of these chlorinated hydrocarbons. Numerous literature sources site typical degradation sequences from 1) 1,1,1-trichloroethane to 1,2-dichloroethene (total), 1,1-dichloroethene or 1,1-dichloroethane and then to vinyl chloride and 2) trichloroethene to 1,2-dichloroethene (total) and then to vinyl chloride. Vinyl chloride is not thought to be easily degraded by microbes but is susceptible to hydrolysis has a high volatility and rapidly degrades in the atmosphere. Each of these volatile organic compounds are adsorbed to soil particles especially organic carbon. The following physical and chemical properties that are expected to affect relative persistence are reported for the four volatile organics of concern:

Water solubility (mg/l):	trichloroethene 1100; 1,2-dichloroethene 600 to 800; vinyl chloride 2,670; and 1,1,1-trichloroethane 720
Vapor pressure (torr):	trichloroethene 58; 1,2-dichloroethene 200 to 360; vinyl chloride 2580; and 1,1,1-trichloroethane 100.

Octanol/water partion coefficient (mg/l):	1,1,1-trichloroethene 120; 1,2-dichloroethene 59; vinyl chloride 57; and trichloroethane 152.

5.3 Contaminant Migration

Historic activities at the Hi-Mill site may have resulted in transport of contaminants via several pathways. Overflows of the removed lagoons may have transported metals directly onto soils and into the Target Wetland. Spray evaporation of lagoon water may have resulted in the airborne migration of metals. Infiltration of water from the removed lagoons may have resulted in groundwater transport of metals. The only significant route of transport thought to currently be active is groundwater migration. Groundwater migration is suspected to be transporting dissolved metals and volatile organics in the shallow groundwater.

DRAFT
ENDANGERMENT ASSESSMENT

HI-MILL MANUFACTURING COMPANY
HIGHLAND, MICHIGAN

6.0 BASELINE RISK ASSESSMENT

6.1 Introduction

6.1.1 Purpose and Scope

This report presents the results of a baseline risk assessment that was performed in conjunction with a Remedial Investigation conducted at the Hi-Mill CERCLA site between November 6, 1989 and May 11, 1990. The objective of the study is to define and to evaluate the ecological and human health risks associated with the inorganic and organic contaminants found within the site soils, groundwater, surface water and sediments. Information obtained during the human health and ecological evaluations for the baseline risk assessment will be used during the Remedial Investigation/Feasibility Study for the purpose of ensuring that the selected remedy will be protective of human health and the environment.

Information developed for the baseline risk assessment includes: identification of the hazardous substances present at the site; assessment of exposure and exposure pathways; the environmental fate and transport of the hazardous substances present; assessment of the toxicity of the hazardous substances present; characterization of the human health risks present and characterization of the impacts and/or risks to the environment.

6.1.2 Contents of the Baseline Risk Assessment

The baseline risk assessment consists of an evaluation of human health risks, involving assessment of exposure, chemical toxicity and characterization of risk under current and alternate future site conditions, evaluation of ecological impacts and a summary and conclusions section in which the results of the risk assessment are discussed in relation to recommended remedial action objectives. Risk assessment procedures used in the study followed evaluation methodologies discussed in "Risk Assessment Guidance for Superfund. Volume I. Human Health Evaluation Manual, Part A", United States Environmental Protection Agency, Washington, DC, December, 1989.

Section 6.2 presents the following results of the exposure assessment: nature and extent of contamination; identification of the contaminants of concern for the site; the exposure pathways which exist at the site; analysis of the exposed populations; reasonable maximum expected levels of contaminants of concern and the estimated chemical intakes for each of the four media (soils, groundwater, surface water and sediments). Reasonable maximum exposure concentration for site-related inorganic chemicals were based upon the geometric mean of all sample concentrations for each analyte. For organic parameters, the maximum measured concentration was used in estimating chemical intake.

Section 6.3 presents a toxicity assessment for the contaminants of concern. Toxicity data is gathered from approved sources (i.e., the Integrated Risk Information System, Health Effects Assessment Summary Tables and the Agency for Toxic Substances and Disease Registry) and is used in evaluation of the carcinogenic and non-carcinogenic effects of site-related chemicals.

Section 6.4 presents a discussion of the risk characterization for the site in which information from the toxicity and exposure assessments is organized and used to quantify pathway risks for each substance, and to determine the total cancer risk and non-cancer hazard index for each pathway and across pathways.

Section 6.5 presents the results of the evaluation of environmental/ecological risks resulting from the presence of contaminants identified in the Remedial Investigation.

Section 6.6 provides a summary of the findings of the baseline risk assessment and the human health risks associated with the nature and extent of contamination found at the site. Data limitations and recommendations for future work and for remedial action objectives are presented.

6.2 Exposure Assessment

6.2.1 Site Soils: Nature and Extent of Contamination

Table 6-1 presents a summary of the soils sample results by sample depth and includes the following: number of soil samples collected by parameter group; range of quantitation limits for each analyte of concern; range of detected concentrations and frequency of detection.

A soils master data table is presented as Appendix C. The soils master data table includes sample ID, ENCOTEC laboratory ID number, descriptions of soils type, sample collection date, boring east location coordinate, boring north location coordinate, and sample type.

The identification of site-related inorganic contaminants of concern was based on presence at concentrations above background criteria (BC). The background criteria was determined from the chemical analysis data from the representative background samples collected during the RI. A preliminary evaluation of the analysis data for the ten (10) background samples indicated that both samples collected at BG2 and one sample (BG4-1) collected at BG4 were not representative because the concentrations of several metals were clearly higher than the general trend observed in all other samples. BG2, being proximate to the manufacturing building, is assumed to have been impacted by site activities. The sample from BG4-1, while not proximate to site activities, was observed in the laboratory to have significantly different soils characteristics when compared to the other samples. The analysis data from these three (3) apparently non-representative samples were omitted from all background calculations.

Analysis data from the seven (7) representative samples were used to determine the BC. The BC was established as the mean, at the 95% confidence interval (mean value plus two (2) standard deviations) of all measurements for a given analyte. When the analysis results were reported as below detection limit (U flag), the value of the detection limit and zero (0) were alternated in the mean calculation. In other words, the detection limit value was used for the first "U" flagged result encountered, zerowas entered for the next "U" flagged value, the detection limit value was used for the next "U" flagged result encountered, etc. The results from foreground sample analyses were then compared to the BC to determine which contaminants were present at elevated levels. This data then revealed the contaminants of concern and the extent of contamination.

TABL[illegible].1

SOILS (mg/kg)

Chemical	Inorganic Chemicals of Concern (mg/kg)							Organic Chemicals of Concern (mg/kg)			
	Aluminum	Chromium	Copper	Nickel	Silver	Zinc	Lead	Vinyl Chloride	Trichloroethylene	1,2-Dichloroethylene	1,1,1 Trichloroethane
Surface											
No. of Samples	91	91	91	91	91	91	8 (Site)	25	25	25	25
No. of Field Duplicates	4	4	4	4	4	4	0	0	0	0	0
Frequency of Detection	91	91	80	91	91	91	8	0	10	1	1
Range of Sample Quantitation Limits			2.40-3.60		2.20-22.0		2.00	0.012	0.006	0.006	0.002
Range of Detected Concentrations	3490-25900	4.50-4420	4.10-5010	5.90-33.30		22-844	17.5-60.0	ND	0.007-0.043	0.140	0.140
Depth 2											
No. of Samples	17	17	17	17	17	17	5	21	21	21	21
No. of Field Duplicates	0	0	0	0	0	0	1	2	2	2	2
Frequency of Detection	16	17	16	17	1	17	6	0	3	0	0
Range of Sample Quantitation Limits			2.2		2.00-2.3		2.0	0.012	0.006	0.006	0.002
Range of Detected Concentrations	2,610-27,100	6.2-615	5.9-2,500	8.6-34.6	4.6	19.9-89.7	4.4-22.5		0.002-0.041		
Depth 3 Soil/Clay Interface											
No. of Samples	39	39	39	39	39	39	0	38	38	38	38
No. of Field Duplicates	0	0	0	0	0	0	0	0	0	0	0
Frequency of Detection	39	39	6	39	1	39	0	0	7	2	1
Range of Sample Quantiation Limits	—	—	2.3-2.6	—	2.1-2.2	—	—	0.012	0.006	0.006	0.002
Range of Detected Concentrations	6,440-22,500	5.7-1,620	4.7-4,400	4.9-33	33.70	17.6-244	—	—	0.002-0.24	0.002-0.130	0.011
Below S/C Interface											
No. of Samples	27	27	27	27	27	27	0	63	63	63	63
No. of Field Duplicates	2	2	2	2	2	2	0	0	0	0	0
Frequency of Detection	29	29	6	29	0	29	0	0	13	8	0
Range of Sample Quantitation Limits	—	—	2.3-2.5	—	2.1-2.3		—	0.012			0.001-0.002
Range of Detected Concentrations	6,520-14,500	13.3-26.8	5.4-42.4	10.8-30.6	—	27.6-59.1	—	—	0.001-5.7	0.009-0.098	—

Short List Metals

Short list metal concentrations in background samples, including mean background concentrations and standard deviations are presented in Table 4-1 of the Draft Remedial Investigation Report. Table 4-2 of the Draft Remedial Investigation Report presents soils analyses with short list metal concentrations above mean background concentrations plus two standard deviations.

For copper, the mean background concentration is 4.3 mg/kg, the maximum background concentration is 7.5 mg/kg and that the BC is 8.33 mg/kg. There are 107 foreground locations above 8.33 mg/kg. There are 9 locations above 900 mg/kg. These nine locations of highest concentration are L3, M3, M4, H7, I5, H3/I3, I5-2, L3-2 and H7-2. An isoconcentration map showing the spatial distribution of copper in shallow soil samples is presented in Figure 4-1.

For chromium; the mean background concentration is 14.09 mg/kg, the maximum background concentration is 45.2 mg/kg, and that the BC is 39.7 mg/kg. There are 31 stations above 39.7 mg/kg. The highest concentration is 4420 mg/kg (M3-0). An isoconcentration map showing the spatial distribution of chromium in shallow soils is presented in Figure 4-2.

For zinc; the mean background concentration is 30.30 mg/kg , the highest background concentration is 70.2 mg/kg, and that the BC is 63 mg/kg. There are 38 stations above 63 mg/kg. The 4 highest detections are K6-0 (844 mg/kg), B1-0 (834 mg/kg), J5-0 (573 mg/kg), and E2-0 (350 mg/kg). It should be noted that the results of duplicate analysis for B1-0D (B1-0) is only 259 mg/kg.

For aluminum; the mean background concentration is 8054 mg/kg, the highest background concentration is 26,400 mg/kg and that the BC is 23,174 mg/kg. Six locations have values above 23,174 mg/kg. The highest concentration is 27,100 mg/kg at both H-7 and I-7.

For nickel; the mean background concentration is 11.26 mg/kg, the highest background concentration is 50.2 mg/kg and that the BC is 43.1 mg/kg. No locations (except for background location BG-4-1) are above 43.1 mg/kg.

For silver; the mean background concentration is 2.27 mg/kg, the highest background concentration is 2.4 mg/kg and that the BC is 2.51 mg/kg. The highest concentration is 3.80 mg/kg in K6-0. All analyses results have UN flags except L4-0 which only has a U flag.

TAL Inorganics

The identification of contaminants of concern was based on presence at concentrations above background criteria (BC). The background criteria was determined from the chemical analysis data from the representative background samples collected during the RI. A preliminary evaluation of the analysis data for the ten (10) background samples indicated that both samples collected at BG2 and one sample collected (BG4-1) at BG4 were not representative because the concentrations of several metals were clearly higher than the general trend observed in all other samples. BG2, being proximate to the manufacturing building, is assumed to have been impacted by site activities. The sample from BG4-1, while not proximate to site activities, was observed in the laboratory to have significantly different soils characteristics when compared to the other samples. The analysis data from these three (3) apparently non-representative samples were omitted from all background calculations.

Analysis data from the seven (7) representative samples were used to determine the BC. The BC was established as the mean, at the 95% confidence interval (mean value plus two (2) standard deviations) of all measurements for a given analyte. When the analysis results were reported as below detection limit (U flag), the value of the detection limit and zero (0) were alternated in the mean calculation. In other words, the detection limit value was used for the first "U" flagged result encountered, zero (0) was entered for the next "U" flagged value, the detection limit value was used for the next "U" flagged result encountered, etc. The results from foreground sample analyses were then compared to the BC to determine which contaminants were present at elevated levels. This data then revealed the contaminants of concern and the extent of contamination.

Table 4-3 of the RI report shows the mean background concentrations and background criteria for each of the 24 target analytes at 9 sample locations. All measurements of Sb, Hg, Se, Ag, Na, Tl, and CN were less than or equal to the respective background criteria. As, Be, Cd and Mn have two or less excedances above their respective background criteria.

Lead has three excedances above the BC level. These are concentrations of 60.0 mg/kg (G7-0), 22.5 mg/kg (I4-2) and 21.1 mg/kg (C4), which exceed 16.82 mg/kg (BC).

Barium, calcium, iron magnesium, potassium and vanadium and previously discussed short list metals had more than three excedances above their respective BC. Vanadium, barium, iron and aluminum concentrations appear to vary in a related manner. No clear relationship is obvious for the other potentially elevated analytes.

TCL Volatile Organics

Samples for TCL volatile organic analyses in soils were obtained at I4-2 and G4-2 and within the RST-01234 and VWXYZ-012 grids, as shown on Figure 2-3. Detections of TCL volatile organics without B, J or BJ flags are presented in Table 4-4.

Acetone, methylene chloride, and toluene were detected in I4-2 at concentrations of 0.015, 0.006 and 0.007 mg/kg, respectively. Methylene chloride, toluene and trichloroethene were detected in G4-2 with B and J flags. No other volatile organic compounds were detected outside of the RST-01234 and VWXYZ-012 grids.

The RST-01234 grid had unflagged volatile organic compounds detected in samples from all 8 sample points. Volatile organic compounds detected were methylene chloride, toluene, acetone, xylene (total), trichloroethene, 1,2-dichloroethene (total), 1,1,1-trichloroethane, ethylbenzene, chlorobenzene, and 2-butanone. Methylene chloride, toluene, xylene, ethylbenzene and 2-butanone are only reported in analyses with B, J, or BJ flags. The number of unflagged detections per compound were: trichloroethene, 10; 1,2 dichloroethene (total) 4; 1,1,1 trichloroethane 2; chlorobenzene, 1; and acetone, 1. Volatile organic compounds reported present without B, J or BJ flags with highest concentrations in parentheses were: trichloroethene (0.350 mg/kg), 1,2 dichloroethene (0.041 mg/kg), 1,1,1-trichloroethane (0.140 mg/kg), chlorobenzene (0.014 mg/kg) and acetone (0.086 mg/kg).

Unflagged volatile organic compounds were detected at five of seven locations in the VWXYZ-012 grid. The following volatile organic compounds were detected: trichloroethene, 1,2- dichloroethene (total), acetone, methylene chloride, toluene, 2-butanone, 1,1,1-trichloroethane, 1,1,2,2-tetrachloroethane, 1,1,2 trichloroethane, and chlorobenzene. Chlorobenzene, 2-butanone, 1,1,1-trichloroethane, 1,1,2,2-tetrachloroethane, and 1,1,2-trichloroethane are only reported in analyses with B, J, or BJ flags. The number of unflagged detections for each compound was: trichloroethene, 15; 1,2-dichloroethene (total), 5; acetone, 2; methylene chloride 1; and toluene 3. The following volatile organic compounds (with highest concentration in parentheses) were detected without J, B, or JB flags: trichloroethene (57 mg/kg), 1,2-dichloroethene (total) (0.140 mg/kg), acetone (0.065 mg/kg), methylene chloride (0.012 mg/kg) and toluene (0.015 mg/kg).

TCL Organics

Reported detections for extractable (BNA), PCB and pesticide fractions are presented in Table 4-5 for both background and non-background locations. Compounds detected in both background and non-background locations were di-n-butylphthlalate; and bis(2-ethlylhexyl)phthalate. Samples detected only in background were dibenz(a,h)anthracene; benzo(b)fluoranthene; fluoranthene; benzo(a)pyrene; indeno(1,2,3-cd)pyrene; butyl benzyl phthalate; benzo(a)anthracene; benzo(g,h,i)perylene; chrysene; phenanthrene; and pyrene. No compounds were detected in non-background locations without J flags. The only TCL organic compound (excluding volatile organic compounds discussed above) detected without B, J or BJ flags in any sample was bis(2-ethylhexyl)phthalate in one background sample. Reported background levels were 0.590 mg/kg.

6.2.2 Groundwater: Nature and Extent of Contamination

A groundwater master data table is presented as Appendix D. The groundwater master data table includes sample ID, ENCOTEC laboratory ID number, partial descriptions of aquifer type, bottom of screen depth, sample collection date, project east location coordinate, project north location coordinate, top of screen elevation, and sample type.

Table 6-2 presents a summary of the sample results for the three aquifers investigated that includes number of water samples collected by parameter group, range of quantitation limits for each analyte of concern, and range of detected concentrations and frequency of detection.

Inorganics

Analyses of groundwater for dissolved TAL inorganics was performed on samples from shallow wells SW-2, SW-5, SW-8 and SW-22 and intermediate wells IW-1, IW-3 and IW-5. Analyses for dissolved short list metals were performed on samples from all shallow wells, intermediate wells, deep wells and in the pre-existing shallow wells EW-1, EW-2, EW-4 and EW-6.

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TABLE 6.2
GROUNDWATER (mg/l)

Chemical	Aluminum	Chromium	Copper	Nickel	Silver	Zinc	Lead	Vinyl Chloride	Trichloroethylene	1,2-Dichloroethylene	1,1,1 Trichloroethane
	Inorganic Chemicals of Concern (mg/l)							Volatile Organic Chemicals of Concern (mg/l)			
Shallow Aquifer											
No. of Samples	26	26	26	26	26	26	4	12	12	12	12
No. of Field Duplicates	2	2	2	2	2	2	1	3	3	3	3
Frequency of Detection	2	5	3	0	7	5	0	1	2	7	0
Range of Sample Quantitation Limits	85.00-114.00	7.00-9.00	10.0-11.0	11.0	9.00	5.00-6.00	2.00	0.010-0.100	0.005-0.050	0.005-0.050	0.005-0.050
Range of Detected Concentrations	208-648	12.80-45.80	33.80-98-70	---	14.60	7.20-22.20	---	0.068	0.014-1.10	0.030-0.360	---
Intermediate Aquifer											
No. of Samples	5	5	5	5	5	5	3	5	5	5	5
No. of Field Duplicates	0	0	0	0	0	0	0	0	0	0	0
Frequency of Detection	0	2	0	0		0	7	0	0	0	0
Range of Sample Quantitation Limits	85.00-114.00	7.00-9.00	10.00-11.00	11.00-19.00	8.00-9.00	5.00-6.00	2.00	0.010	0.005	0.005-0.050	0.005-0.050
Range of Detected Concentrations	---	16.00-20.70	---	---	---	--	2.50	---	---	---	---
Deep Aquifer											
No. of Samples	3	3	3	3	3	3	0	3	3	3	3
No. of Field Duplicates	1	1	1	1	1	1	0	0	0	0	0
Frequency of Detection	0	0	0	0	0	1		0	0	0	0
Range of Sample Quantiation Limits	85.00-114.00	7.00-9.00	10.00-11.00	11.00-17.00	8.00-9.00	5.00-6.00	---	0.010	0.005	0.005-0.050	0.005-0.050
Range of Detected Concentrations	---	---	---	---	---	7.70	---	---	---	---	---

A summary table of analytical results for TAL inorganic analyses of groundwater is presented in Appendix K, and a summary of short list metal analysis results is presented in Appendix L. A summary table of ammonia and nitrate/nitrite analysis results is presented as Appendix M.

Short List Metals

Short list metals in groundwater were reported in the following ranges of concentrations: aluminum, from below the detection limit of 85 μg/l to a maximum concentration of 648 μg/l (SW-20); chromium, from below the detection limit of 7 μg/l to a maximum concentration of 45.8 μg/l (SW-15); copper, from below the detection limit of 10.0 μg/l to a maximum concentration of 98.7 μg/l SW-7; nickel, from below the detection limit of 11.0 μg/l to a maximum concentration of 149.0* μg/l (SW-15); silver, from below the detection limit of 9.0 μg/l to a maximum concentration of 14.6N μg/l (SW-20); and zinc, from below the detection limit of 5.0 μg/l to a maximum concentration of 22.0 μg/l (SW-7). All detections of short list metals in groundwater without U, B, and/or N flags are presented in Table 4-6.

TAL Inorganics

TAL inorganics in groundwater were reported in the following ranges of concentrations: aluminum from below the detection limit of 85.00 μg/l to a maximum concentration of 208 μg/l (SW-22); antimony, from below the detection limits of 51.0 μg/l to 56.0 μg/l; arsenic, all were below the detection limit of 3.0 μg/l; barium, from below the detection limit of 23.0 μg/l to a maximum concentration of 59.10B μg/l in SW-8D; beryllium, from below the detection limits of 1.00 μg/l to 2.00 μg/l; cadmium, all were below detection limit of 2.00 μg/l; calcium, from a minimum concentration of 59,000 μg/l (SW-2) to a maximum concentration of 305,000 μg/l (SW-8); chromium, from the detection limit of 9.0 μg/l to a maximum concentration of 30.20* μg/l (SW-2); cobalt, from below the detection limits of 9.0 μg/l to 14.0 μg/l; copper, from below the detection limits of 10.0 μg/l to 11.0 μg/l; iron, from below the detection limit of 29.00 μg/l to a maximum concentration of 391.00 μg/l (IW-3); lead, from below the detection limit of 2.00 μg/l to a maximum concentration of 2.20B μg/l; magnesium, from a minimum concentration of 18,000 μg/l (IW-3) to a maximum concentration of 529,000 μg/l in SW-22; manganese, from a minimum concentration of 49.2 μg/l (IW-5) to a maximum concentration of 811.00 μg/l (SW-5); mercury, all were below the detection limit of 0.20 μg/l; nickel, from below the detection limit of 11.00 μg/l to a maximum concentration of 20.30B μg/l (SW-22); potassium, from a minimum concentration of 905.00B μg/l (SW-2) to a maximum concentration of 11,500 μg/l (SW-5); selenium, all were below the detection limit of 1.00 μg/l; silver, from below the detection limit of 8.00 μg/l to a maximum concentration of 10.90 μg/l (SW-8-FB); sodium, from a minimum concentration of 3,450.00B μg/l (SW-2) to a maximum concentration of 579,000 μg/l (SW-22); thallium, all samples were below the detection limit of 4.00 μg/l; vanadium, from below the detection limit of 8.00 μg/l to a maximum concentration of 1090B μg/l (IW-5); zinc, from below the detection limits of 5.00 μg/l to 6.00 μg/l; and cyanide, from below detection limit of 10.00 μg/l to a maximum concentration of 37.00 μg/l (SW-5).

Ammonia and Nitrate/Nitrite

Ammonia and nitrate/nitrite analyses were performed on groundwater from SW-1, SW-2, SW-3, SW-4, SW-5, SW-6, SW-8, SW-10, SW-11, SW-12, SW-14, SW-15, SW-17, SW-18, SW-19, SW-20, and SW-21. Ammonia concentrations ranged from below the method detection limit of 50.00 μg/l to 2200.00 μg/l in SW-22. All reported ammonia analyses had A and C flags. Nitrate plus nitrite concentrations ranged from below the method detection limit of 50.00 μg/l to 16,000 μg/l in SW-5. All reported nitrate plus nitrite analyses had A and C flags.

TCL Volatile Organics

TCL volatile organic compounds were analyzed in groundwater samples from shallow wells SW-1, SW-2, SW-3, SW-4, SW-5, SW-6, SW-8, SW-10, SW-11, SW-12, SW-20, SW-22; intermediate wells, IW-1, IW-2, IW-3, IW-4, IW-5; and deep wells DW-1, DW-2 and DW-3. A summary of all analytical results above detection limits is presented in Appendix J. TCL volatile organic compounds detected above the detection limits are presented in Table 4-7 of the RI report. The samples in which volatile organics were detected were as follows: trichloroethene, SW-1 and SW-3; 1,2 dichloroethene (total), SW-3, SW-5, SW-5D, SW-10, SW-10D, SW-10MS; vinyl chloride, SW-3; methylene chloride, DW-3, IW-2, IW-5, SW-22, SW-22D, SW-22FB, and MW-TB. The highest concentration and location are: trichloroethene (1,100 μg/l in SW-1), 1,2 dichloroethene (total) (360 μg/l in SW-1), vinyl chloride (68 μg/l in SW-3), methylene chloride (29 μg/l in SW-22FB), and acetone (11 μg/l in MW-TB).

TCL Organics

TCL organic analyses were performed on groundwater from SW-2, SW-2D, SW-2FB, SW-5, SW-8 and IW-1. Di-n-butyl phthalate (8 $\mu g/l$ in SW-2) was the only base-neutral or acid extractable compound detected in groundwater samples. Pesticides and PCB analyses were not performed on groundwater samples.

6.2.3 Surface Water: Nature and Extent of Contamination

A surface water master data table is presented as Appendix A. The surface water master data table presents station, sample ID, ENCOTEC sample ID number, sample collection date, project east location coordinate, project north location coordinate, elevation and sample type for each surface water sample point.

Table 6-3 presents a summary of the sample results for the three surface water bodies investigated during the RI (i.e., the Background Pond (BP), Waterbury Lake (WL) and the Target Pond (TP)) that includes the following: number of water samples collected for each parameter group; number of water samples collected by parameter group; range of quantitation limits for each analyte of concern; range of detected concentrations and frequency of detection.

Inorganics

Analyses for short list metals were performed on samples from BP-1, BP-2, BP-3, TP-1, TP-4, TP-4FB,TP-10, TP-10D, WL-1 and WL-2. TAL inorganic analyses were performed on BP-4, TP-2, TP-7, TP-7D, TP-11, TP-11D, and TP-11FB. Ammonia and nitrate plus nitrite analyses were performed on BP-1, BP-2, BP-3, BP-4, TP-7, TP-7D, TP-10, and WL-2. Hexavalent chromium analyses were performed on samples from BP-1, BP-2, BP-3, BP-4, TP-1, TP-2, TP-2FB, TP-4, TP-4DTP-7, TP-9, TP-10, TP-10D, TP-11, WL-1, and WL-2.

TABLE 6.3
SURFACE WATER

Chemical		Inorganic Chemicals of Concern (mg/l)						
		Aluminum	Chromium	Copper	Nickel	Silver	Zinc	Lead
Surface								
No. of Samples:	BP	4	4	4	4	4	4	1
	TP	7	7	7	7	7	7	3
	WL	2	2	2	2	2	2	0
No. of Field Duplicates		2	2	2	2	2	2	1
Frequency of Detection		1	5	3	0	1	8	2
Range of Sample Quantitation Limits		85.00	7.00	10.00	11.0	9.0	6.0	2.0-10.0
Range of Detected Concentrations		5360	9.3-38.5	13.00-21.4	---	12.5	12.40-15.7	3.1-10.0

BP = Background Pond TP = Target Pond WL = Waterbury Lake

Short List Metals

Short list metals in surface water had the following range of concentrations and sample quantitation limits reported: aluminum below the detection limit of 85.00 μg/l for all samples except TP-9 (5360 μg/l); chromium, below the detection limit for all samples except TP-1 (13.00 μg/l); copper, below the detection limit for all samples except BP-1 (19.50 BN) and TP-10 (21.40); nickel, below detection limit of 19.00 μg/l for all samples; silver, from below the detection limit of 9.00 μg/l to a maximum concentration of 12.50N μg/l in BP-2; and zinc, from below the detection limit of 6.00 μg/l and a maximum concentration of 16.20B μg/l in TP-10D.

TAL Inorganics

The following TAL inorganics were below detection limits in all surface water samples (limits in parentheses): aluminum (85.00 μg/l); arsenic (3.00 μg/l); barium (42.00 μg/l); beryllium (1.00 μg/l); cadmium (2.00 μg/l); cobalt (14.00 μg/l; mercury (0.20 μg/l); nickel (11.00 μg/l); selenium (1.00 μg/l); thallium (4.00 μg/l); vanadium (8.00 μg/l); and cyanide 10.00 μg/l). Surface water samples for all locations were below background surface water station BP-4 for antimony (background, 65.40 μg/l) and zinc (background, 12.40 μg/l).

TAL inorganic concentrations for all other compounds are presented below for the background sample (BP-4), lowest sample location and highest sample location: calcium, 26500.00 μg/l (BP-4), 13,300.00 μg/l (TP-11 FB),and 44,500.00 μg/l (TP-7); chromium, 9.30* μg/l (BP-4), 7.00* μg/l (TP-2), and 38.50* μg/l (TP-11); copper, less than the detection limit of 10.00 μg/l for all samples except TP-11 (13.00B μg/l); iron, less than the detection limit (BP-4), 625.00 μg/l (TP-11); lead, 3.30 μg/l (BP-4), less than the detection limit (TP-2), and 7.80 μg/l (TP-11FB); magnesium, 5050.00 μg/l (BP-4), less than the detection limit (TP-11FB), and 11,800 μg/l (TP-7); manganese, 7.30B (BP-4), less than detection limit (TP-11FB), and 378.00 μg/l (TP-11); potassium, 817.00B μg/l (BP-4), less than the detection limit of 788.00 μg/l (TP-11FB), and 3880.00B μg/l (TP-7); silver, less than detection limit of 9.00 μg/l in all samples except TP-7 (9.10B μg/l); and sodium, 2620.00B (BP-4), less than detection limit of 1,080.00 μg/l (TP-11FB), and 26,000.00 μg/l (TP-7).

Hexavalent chromium was less than the detection limit of 10.00 μg/l at all surface water locations.

Ammonia and Nitrate/Nitrite

Ammonia analyses were performed on surface water samples from BP-1, BP-2, BP-3, BP-4, and TP-07FB. Nitrate/nitrite analyses were performed on surface water samples from BP-1, BP-2, BP-3, BP-4, TP-7, TP-7D, TP-7FB and WL-2.

Ammonia concentrations ranged from below the detection limit of 50.00 $\mu g/l$ to a maximum concentration of 160.00AC $\mu g/l$ (BP-1). Nitrate/nitrite concentrations ranged from below the detection limit of 50.00 $\mu g/l$ to a maximum concentration of 1200.00AC $\mu g/l$ in TP-7FB. The concentration in TP-7FB was considerably higher than the next highest concentration of nitrate\nitrite, 180.00AC $\mu g/l$ (BP-1), which was in the background pond.

6.2.4 Sediments: Nature and Extent of Contamination

Table 6-4 presents a summary of the sediment sample results for the three surface water bodies investigated during the RI (i.e., the Background Pond (BP), Waterbury Lake (WL) and the Target Pond (TP)) that includes: number of water samples collected for each parameter group; number of water samples collected by parameter group; range of quantitation limits for each analyte of concern; range of detected concentrations and frequency of detection.

The sediment master data table is presented as Appendix B. The master data table includes sample station number, sample ID number, ENCOTEC laboratory ID number, sample collection date, project east and north coordinates, elevation, and sample type for each sample. Locations of sediment sample points are shown on Figure 2-1 of the RI report.

Inorganics

Short list metals were analyzed at all Background Pond, Target Pond and Waterbury Lake sample locations. A summary of results for those test points that exceded background criteria is presented in Table 4-8. Hexavalent chromium was analysed in samples from locations BP-1, BP-2, BP-3, BP-4, TP-1,TP-4, TP-4-1, TP-5, TP-6, TP-6-1, TP-9, TP-10, WL-1, WL-2, and WL-2D.

TABLE 6.4

SEDIMENTS (mg/kg)

Chemical		Inorganic Chemicals of Concern (mg/l)						
		Aluminum	Chromium	Copper	Nickel	Silver	Zinc	Lead
Surface								
No. of Samples:	**BP**	**4**	**4**	**4**	**4**	**4**	**4**	1
	TP	**17**	**17**	**17**	**17**	**17**	**17**	3
	WL	**2**	**2**	**2**	**2**	**2**	**2**	0
No. of Field Duplicates		**3**	**3**	**3**	**3**	**3**	**3**	1
Frequency of Detection		**26**	**26**	**26**	**26**	**0**	**26**	5
Range of Sample Quantitation Limits		**7.3-29.80**	**2.80-42.60**	**21.80-46.80**	**2.20-38.30**	**18.20-25.50**	**---**	---
Range of Detected Concentrations		**964-33900**	**17.30-974**	**7.00-1860**	**7.30-41.90**	**—**	**41.10-208.00**	3.3-20.7

BP = Background Pond **TP = Target Pond** **WL = Waterbury Lake**

Values for aluminum range from 964 mg/kg to 3610 mg/kg in the Background Pond, from 11,800.00 mg/kg to 33,900.00 mg/kg (TP-2) in the Target Pond, and from 1360.00 mg/kg to 6770.00 mg/kg in Waterbury Lake. All nineteen test points in the Target Wetland and one sample point in Waterbury Lake (WL-02) exceded the BC of 4842 mg/kg.

Values for chromium range from less than detection (20.30U mg/kg) to 37.10 mg/kg in the Background Pond, from 17.30 mg/kg to 256.00 mg/kg (TP-8) in the Target Pond, and from less than detection (7.30U mg/kg) to 51.80 mg/kg in Waterbury Lake. Three test points in the Target Wetland (TP04-0, TP07-0, and TP08-0) and one point in Waterbury Lake (WL01) exceded the BC of 50.65 mg/kg.

Values for copper range from less than detection (28.20U mg/kg) to 37.10 mg/kg in the Background Pond, from 17.30 mg/kg to 256.00 mg/kg in the Target Pond, and from less than detection (10.40U mg/kg) to 486.00 mg/kg in Waterbury Lake. Eight test points in the Target Wetland and one test point in Waterbury Lake (WL01) exceded the BC of 54.91 mg/kg.

Values for nickel range from less than detection (31.00U mg/kg) to less than detection (46.80U mg/kg) in the Background Pond, from 7.30B mg/kg to 41.90 mg/kg (TP-04) in the Target Pond, and from less than detection (21.80U mg/kg) to 28.10B mg/kg in Waterbury Lake. None of the test points exceded the highest detection limit of the background samples (46.8 mg/kg).

Values for silver were reported below detection limits for all samples.

Values for zinc range from 18.20U mg/kg to 122.00 mg/kg in the Background Pond, from 42.70 mg/kg to 208.00 mg/kg (TP-8) in the Target Pond, and from 56.90 mg/kg to 75.90 mg/kg in Waterbury Lake. One sample point in the Target Pond (TP08-0) exceded the BC of 162.23 mg/kg.

Analysis results for hexavalent chromium at all sample locations were below the detection limits of 0.10 mg/kg to 2.00 mg/kg.

Ammonia and Nitrate/Nitrite

Ammonia analyses were performed on surface water samples from BP-1, BP-2, BP-3, BP-4, and TP-07FB. Nitrate/nitrite analyses were performed on surface water samples from BP-1, BP-2, BP-3, BP-4, TP-7, TP-7D, TP-7FB and WL-2.

Ammonia concentrations ranged from below the detection limit of 50.00 μg/l to a maximum concentration of 160.00AC μg/l (BP-1). Nitrate/nitrite concentrations ranged from below the detection limit of 50.00 μg/l to a maximum concentration of 1200.00AC μg/l in TP-7FB. The concentration in TP-7FB was considerably higher than the next highest concentration of nitrate\nitrite, 180.00AC μg/l (BP-1).

6.2.5 Evaluation and Selection of Chemicals of Concern

Summaries of conclusions based on the Remedial Investigation results are presented in the following paragraphs. Rationale for selection of chemicals of concenr to be carried through the risk assessment are presented at the end of this subsection.

<u>Conclusions - Soils</u>

Based upon evaluations of the Remedial Investigation site assessment data presented in Sections 3 and 4 in the RI report, contaminated soils within the investigation area can be divided into three areas for purposes of contamination assessment, risk evaluation and remedial feasibility planning. These areas are the area between the production facility and the Target Wetland, the general vicinity of the small eastern assessment area VWXYZ-012, and the general vicinity of the small western assessment area, RST-01234.

Soils located between the production facility and the Target Wetland were found to contain elevated levels of certain metals. This area appears to be roughly bounded by portions of the sample grid, but has not been fully defined.

Area Between Production Facility and Target Wetland

TAL analytes Ag, As, Be, Cd, Pd, and Mn were all measured at levels greater than their respective BC but in three or fewer samples. These results indicate that these metals are not characteristic of significant site contamination and need not be addressed further. TAL analytes, Al, Ba, Ca, Cr, Cu, Fe, Mg, Ni, K, V and Zn were all measured at levels greater than their repctive BCs in multiple samples. The most significant site wide contamination is represented by the metals Al, Cr, Cu, Ni, and Zn. There are clearly locations containing significantly elevated concentrations of these metals. However, the areal extent of contamination indicated by the number of results above BC (Table 4-2) may be significantly overstated for these five metals. This statement is based upon a evaluation of the step-shaped distribution of concentrations in foreground samples. For each metal there is a large cluster of results which indicate slight elevation above the BC. There is no basis to assume that the selected background locations include all naturally occuring soil types. This may have resulted in a negative bias in the BC, making the number of excedences unreasonably high.

Chromium and copper appear to be reasonable indicators for the extent of metals contamination. The highest levels of contamination were generally found at or above the soil clay interface. The clay layer appears to be a barrier to downward migration. The locations of highest concentrations generally lie near and immediately southeast of the former lagoons and in the vicinity of grid location L3, L4, M3, and M4.

Grid Area VWXYZ-012

The TAL species Al. Ba. Ca, Cr, Cu, Fe, Mg, Ni, K, V and Zn were measured in concentrations above their respective BCs. Copper appears to be a reasonable indicator for metals contamination in this area. The highest levels of conmtamination were generally found at or above the soil clay interface. The clay layer appears to be a barrier to downward migration of metals.

The TCL volatile specie toluene was measured in two samples at concentrations of 8 μg/kg and 12 μg/kg. Since these values are only slightly elevated above CRDL, and toluene was not detected without flags in any other site soil sample, toluene is not considered a significant of concern. No other TCL organic species were detected without flags in this area.

Grid Area RST-01234

The TAL species Al, Cr, Cu, Ni and Zn were measured in concentrations above their respective BCs. However, greater than 95% of these values are in the cluster of measurements which are slightly elevated above BC. The highest levels of conmtamination were generally found at or above the soil clay interface. The clay layer appears to be a barrier to downward migration of metals.

The TCL volatile species trichloroethene, 1,1,1-trichloroethane and/or chlorobenzene were measured in nine samples from this area. Chlorobenzene was detected in only one sample (14 $\mu g/kg$) collected during the Remedial Investigation; therefore it is reasonable to assume that this detection is an artifact or an isolated detection. Chlorobenzene is not considered a contaminant of concern within this grid or at the site. The other two volatile organic compounds were measured at concentrations between 7 $\mu g/kg$ and 350 $\mu g/kg$.

Conclusions - Groundwater

Groundwater investigations were divided into three zones, shallow, intermediate and deep. Remedial Investigation data presented in Sections 3 and 4 of this report confirm that these are distinct zones as evidenced by the presence of clay layers, variability in flow direction and gradient, and differences in hydraulic potential. Therefore, it is appropriate to continue discussion groundwater in terms of three distinct zones.

Shallow Saturated Zone

The TAL species detected in shallow groundwater were Al, Ag, Ca, Cr, Cu. Fe, Mg, Mn, K, Na, and Zn. Al, Ca, Fe, Mg, Mn K and Na are commonly occurring cations in groundwater. Since no groundwater background location has been established, there is no basis for identifying these species as contaminants at this time. However, based upon evaluations of general concentration trends, SW-5 has levels of Na, Mn, Ca, and K that may be significantly elevated; SW-8 has levels of Na, Mg, Mn, and Ca that may be significantly elevated; SW-20 has an aluminum level that may be significantly elevated; and SW-22 has levels of Al, Mg and Ca that may be significantly elevated.

Silver was only detected in SW-20, east of the Target Wetland. The groundwater flow direction in the shallow aquifer and the absence of silver in any other water sample indicates that the silver detected in SW-20 is not related to the Hi-Mill site. However, groundwater flow direction in the vicinity of SW-20 indicates that potential sources of this species would be toward the east, in the general vicinity of Numatics, Inc.

Chromium was the most frequently detected metal in the shallow aquifer. It was measured at elevated levels in three shallow wells between the production building and the Target Pond and in SW-15 southwest of the Target Pond. Copper was only detected in two wells, located between the production building and the Target Pond. Zinc was detected in two wells, one located between the production building and the Target Pond and one (SW-20) located east of the Target Wetland. The groundwater flow direction in the shallow aquifer indicates that the zinc detected in SW-20 is not related to the Hi-Mill site. However, groundwater flow direction in the vicinity of SW-20 indicates that potential sources of this species would be toward the east, in the general vicinity of Numatics, Inc. These results indicate that contamination of the shallow zone of saturation is generally confined to the area between the production facility and the Target Pond.

Several TCL volatile organics were detected in shallow monitor wells; however, no extractable TCL organic species were measured. Based upon the types of chemicals used at the Hi-Mill site, chemical analysis flags, identification of common laboratory artifacts, and the infrequent detection, the following species were eliminated from consideration as potentially significant contaminants: methylene chloride, acetone, toluene, and 2-butanone. Trichloroethene, 1,2-dichloroethene (total), and vinyl chloride are considered potentially significant contaminants based upon concentrations and frequency of detections. These contaminants were detected in five wells, and their distribution appears consistent with the direction of groundwater flow and known areas of chemical use or handling. Sampling of additional shallow wells has been recommended for the planned confirmatory groundwater sampling event to futher identify the extent of this contamination.

Intermediate Aquifer

The TAL species detected in groundwater samples from monitor wells in the intermediate aguifer were Ba, Ca, Cr, Fe, Mg, Mn, K, Na and V. Ba, Ca, Fe, Mg, Mn, K and Na are commonly occurring cations in groundwater. Since no groundwater background location has been established, there is no basis for identifying these species as contaminants at this time. Chromium was identified in IW-1 and IW-3, both of which appear to be hydraulicly downgradient of the Hi-Mill former lagoons. Vanadium was only detected in IW-5 and is not thought to be a contaminant of concern based upon its absence in the shallow aquifer and the fact that IW-5 appears to hydraulically upgradient of the Hi-Mill facility.

Several TCL volatile organic species (toluene, methylene chloride, acetone, and 2-butanone) were detected in samples from the intermediate aquifer. Based upon the types of chemicals used at the Hi-Mill site, chemical analysis flags, identification of common laboratory artifacts, and the infrequent detection, all of these species were eliminated from consideration as potentially significant contaminants.

Deep Aquifer

No TAL inorganics contaminants of concern were detected in samples from the deep aquifer. Several TCL volatile organic species (toluene, methylene chloride, acetone, and 2-butanone) were detected in samples from the deep aquifer. Based upon the types of chemicals used at the Hi-Mill site, chemical analysis flags, identification of common laboratory artifacts, and the infrequent detection, all of these species were eliminated from consideration as potentially significant contaminants.

Conclusions - Surface Water and Sediments

The TAL short list metal species detected in surface water were Al and Cr. Hexavalent chromium was not detected in any surface water sample; therefore, the chromium detected in surface water was trivalent. Aluminum was only detected at TP-9. Chromium was only detected at TP-1. These sample points are north of M-59 and in the southernmost end of the Target Wetland, respectively. These data indicate that metals contamination of surface waters near the Hi-Mill site is not of concern.

The TAL short list metals species detected in sediments were Al, Cr, Cu, and Zn. Hexavent chromium was not detected in any sediment samples. Aluminum was found to be elevated in all sediment samples collected from the Target Wetland and slightly elevated in one sample from Waterbury Lake (WL-02).

Elevated levels of chromium in the Target Pond were found in samples collected from the uppermost sediment layer along the shore nearest the Hi-Mill facility (TP-4, TP-7, and TP-8). Elevated levels of chromium were also found in one sample collected at TP-2 in an isolated wet area near Numatics, Inc. Samples from underlying sediments were found to not contain chromium at elevated levels, thus indicating that there is rapid attenuation of concentration with respect to sediment depth. Slightly elevated levels of chromium was detected in Waterbury Lake (WL-1). Since hexavalent chromium was not detected in sediment samples, the all elevated chromium levels in sediments are trivalent chromium.

Elevated levels of copper in the Target Wetland were found in the shallow sediments at eight sample points (TP-4, TP-5, TP-6, TP-7, TP-8, TP-9, TP-10 and TP-12). These points are evenly distributed across the Target Wetland. Samples from underlying sediments were found to not contain copper at elevated levels, thus indicating that there is rapid attenuation of concentration with respect to sediment depth. Elevated copper was also measured in one sample (WL-01) from Waterbury Lake.

Zinc was found to be slightly elevated in only one shallow sediment sample (TP-8). This single data point is insufficient to make zinc a contaminant of concern in the Target Wetland.

The three detections of elevated metals in sediments of Waterbury Lake were aluminum at WL-02, chromium at and copper at WL-01. Aluminum and chromium are only slightly elevated. WL-2 is in the isolated northen arm of Waterbury Lake. Therefore, there is insufficient evidence to indicate that any contaminants of concern are present in the main body Waterbury Lake.

Selection of Chemicals of Concern

The inorganic chemicals that were identified as site-related chemicals (chemicals of concern), based upon exceedances of the background criteria, and that will be carried through the quantitative risk assessment process include the following four short list metals, copper, chromium, nickel, zinc and one TAL inorganic compound, lead.

All unflagged volatile organic compounds detected in site samples are being considered during the risk assessment except for those chemicals that are common lab contaminants (toluene, methylene chloride, acetone and 2-butanone) since sample concentrations for these chemicals were measured at less than ten times the maximum amount detected in any blank. Chlorobenzene, which was detected in only one soil sample at a level slightly above its quantitation limit (0.006 mg/Kg), was not included in the risk quantitation process. The presence of this chemical was considered to be a laboratory artifact or isolated anomaly.

The list of volatile organic compounds that will be carried through the risk assessment process includes trichloroethylene, 1,1,1-trichloroethane, vinyl chloride and 1,2-dichloroethylene.
The only TCL organic compound (excluding volatile organic compounds discussed above) detected without B, J or BJ flags in any sample was bis(2-ethylhexyl)phthalate in one background sample. Reported background levels were 0.590 mg/kg. The presence of this chemical is not considered as site-related.

6.2.6 Exposure Pathways

Elevated levels of chemicals of concern were found in the surface and subsurface soils, surface water and sediments in the adjoining Target Pond and Waterbury Lake, and groundwaters in the shallow and intermediate aquifers. No contaminants were found in groundwater in the deep aquifer.

Table 6-5 presents a matrix of potential exposure pathways and potentially affected populations for the Hi-Mill site, identifying those pathways selected for evaluation and providing rationale for selection or exclusion. The following exposure pathways were judged complete for current/alternate future site use:

- Dermal Contact with surface soil;
- Incidental ingestion of surface soil;
- Occasional ingestion of surface water by swimmers; and
- Ingestion of groundwater.

Significant risk of exposure was not found to exist for any of the pathways judged complete under current use because of 1) present use of the site is industrial with restricted access to those portions of the facility in which contamination of the surface was identified, 2) the surrounding site vicinity is State-owned recreational land of low recreational interest value, 3) area wells do not rely upon the shallow aquifer as a potable water supply except for possible exposures resulting from ingestion of

TABLE 6-5

MATRIX OF POTENTIAL EXPOSURE PATHWAYS

Current/Future Land Use	Release/ Transport Medium	Exposure Point/ Exposure Route	Residential	Commercial/ Industrial	Recreational	Pathway Selected	Rationale
FU	**Groundwater**	**Shallow Aquifer**					
		Incidental Ingestion	U,LP	U	U	YES	Contaminants present in shallow and intermediate
		Dermal Contact	U,LP	U	U	NO	aquifers (chromium in intermediate aquifer, inorganic and VOAs in shallow)
CU/FU		**Intermediate Aquifer**					
		Incidental Ingestion	LP	LP	U	YES	Exposure concentrations not sufficiently elevated
		Dermal Contact	LP	U	U	NO	concern
CU/FU	**Surface Water**	**Target Pond**					
		Incidental Ingestion	U	U	U,LP	YES	
		Dermal Contact					
CU/FU	**Sediment**	**Target Pond**					
		Incidental Ingestion	U	U	U	NO	Sediments are water covered
		Dermal Contact	U	U	U	NO	Sediments are water covered
	Air	**Hi-Mill Site**				NO	No Air Monitoring Data
		Inhalation of Vapor					
		Phase and Particulate Chemicals					
		Indoor					
		Outdoors					
CU/FU	**Soil/Dust**	**Hi-Mill Site**					
		Incidental Ingestion	U	U	U	YES	
		Dermal Contact	U	U	U		
	Food/Fish, Game	**Recreational Area**	U	U	U	NO	

LP = Low Probability of Occurrence U = Exposure Event Unlikely CU/FU = Current/Future Site Use groundwater from the intermediate aquifer. The maximum measured chromium concentration for samples from the intermediate aquifer (0.021 mg/l) which slightly exceeds the Maximum Contaminant Level of 0.02 mg/l for this chemical. The site is located in a rural and sparsely populated area, with the nearest residences situated one quarter-mile distant. Recreational use of the area is limited hiking and hunting activity. No instances of any events likely to result in exposures of any magnitude or frequency were reported by the Highland Park Manager.

Factors that diminish current exposure through any of the above pathways, include recognition of the following:

1) The Hi-Mill site is an industrial facility with restricted access to nearly all portions of the site in which inorganic contamination of the surface soils was discovered. The site is in a rural area, and the probability of exposure, especially for a residential population (i.e. children) is very low. Additional protection would be afforded since the ground surface in the impacted areas is well vegetated;

2) Asphalt paving covers those soils found during the RI to be contaminated with volatile organic substances, so that potential for direct contact is minimal except for such activities as building foundation repair or subsurface excavation;

3) The Target Pond lying due east and south of the facility is too shallow to support a resident fish population, since winter overkill occurs. This eliminates consumption of fish as a pathway. The target pond does not communicate via surficial channels with the nearby Waterbury Lake;

4) The adjoining Target Pond is without a beach or a boat launching area, being ill-suited and undesirable for such recreational uses as boating or swimming activity. Human exposure to substances of concern via ingestion of surface water is, therefore, a highly unlikely, or rarely occurring event.

5) As reported by the Highland Park Recreational Area Manager, recreational use in the site vicinity is limited to deer hunting and occasional hiking. The State of Michigan prohibits firing of any shotgun within 450 feet of any residence or building, a prohibition that is likely to discourage close approach during hunting season.

6) Although inorganic and organic chemicals were detected in the shallow aquifer, residential wells in the site vicinity rely upon the intermediate or deep aquifers for a potable water supply.

However, since alternate future land use may be residential, exposure estimates for calculation of chemical intakes in this risk assessment were highly conservative and based upon assumed exposure to a residential population (e.g., daily contact and lifetime exposure).

6.2.7 Exposed Population Analysis: Current Use

The Hi-Mill Site is a small to medium size industrial facility which occupies approximately 4.5 acres. The site adjoins the Highland Recreational Area. Recreational use in the site vicinity is limited to hiking and hunting for deer and wild game. No residential population is located immediately near the site vicinity (fewer than 15 - 20 households are located within a one-half mile radius of the site).

The Hi-Mill Manufacturing Company operates a single eight hour shift, 5 days per week using an adult work force that is includes male and female workers. Plant operations are totally enclosed within the production building and adjoining warehouse. No work activity is conducted south of the building in the vicinity of the former lagoons (i.e., near areas of the site in which the most significant contamination of the surface was identified during the RI).

Human populations potentially currently exposed to the contaminants found at the site would include the adult industrial worker/employee engaged in grounds-keeping or construction activity and the occasional recreational user (hiker/hunter). Potential for exposure under current use would have a low probability due to the unlikelihood of and/or infrequency of contact.

6.2.8 Exposed Population Analysis: Alternate Future Use

Alternate future use of the site may include possible residential development. Baseline risk assessment of the site considers residential exposures for all pathways judged complete.

6.2.9 Intake Estimates: Exposure Concentrations

Table 6-6 presents for each medium/pathway judged complete and chemical of concern detected in the medium/pathway, a list of the exposure point concentrations used in the risk quantitation process. Media for which specific site-related chemicals were found only at levels below background criteria levels are so identified.

Exposure point concentrations used in the intake estimates were 1) a calculated concentration value that estimates the reasonable maximum exposure by using the geometric mean of all sample concentrations and 2) the maximum measured concentration for the media sampled. For media where there was a low ·quency of detection, the maximum measured concentration was the only exposure point concentration used in the risk calculation process.

6.2.10 Intake Estimates: Factors Used in Predicting Exposures

In the absence of quantative, site-specific data regarding human activity patterns, evaluations for the baseline risk assessment include use of qualitative predictions of contact rate, exposure duration and frequency of exposure. Conservative assumptions regarding contact rates and exposure durations (90 or 95th percentile variable values) were made during the risk characterization process to over-estimate the actual risk and to provide an additional margin of protection.

Intake estimates developed for the baseline risk characterization were based upon possible alternate future residential use, with assumed daily exposures and 70 year duration. For the ingestion of surface water while swimming pathway, however, frequency of exposure was estimated at less than 7 days per year (the national average for engaging in swimming activity) and exposure time was estimated at one-half hour per occurrence.

Tables 6-7 through 6-11 present a summary of chemical intakes quantitations resulting from residential exposure through ingestion of chemicals in soils by the adult and child, ingestion of chemicals in drinking water, occasional ingestion of chemicals in surface water while swimming, and dermal contact with chemicals in soils. Equations and the variables used in the calculations of chemical intake estimates were obtained from the "Risk Assessment Guidance for Superfund" document and have been presented in the tables.

TABLE 6.6

Exposure Concentrations

	Chromium MS<RME>	Copper MS<RME>	Nickel MS<RME>	Zinc MS<RME>	Lead MS<RME>	Trichloro-ethylene MS<RME>	Vinyl Chloride MS<RME	1,1,1-Tri-chlorethane MS<RME>	1,2-Dichloro-ethene MS<RME>
Soils (mg/kg)	**4,420** <24>	**5010** <44.1>	**34.6** <12.9>	**844** <47.4>	**60** <16.8>	**0.043** <0.019>	**ND**	0.140	**ND**
Groundwater (mg/l): **Shallow Aquifer**	**0.045** <0.224>	**0.099** <0.067>	**ND**	**0.022** <11.9>	**ND**	**1.1**	**0.068**	**ND**	**0.036**
Groundwater (mg/l): Intermediate Aquifer	**0.021** <0.0182>	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**
Surface Water (mg/l)	**0.038** <0.017>	**0.021** <0.016>	**ND**	**0.016** <0.012>	**ND**	**NS**	**NS**	**NS**	**NS**

Exposure Concentration Values

MS - Maximum Measured Concentration reported in boldface
<RME> Indicates Reasonably Expected Maximum Concentration

ND - Not Detected
NS - Not Sampled per RI Workplan

TABLE 6.7

Residential Exposure: Ingestion of Chemicals in Soil by Adult

Chemical	Chemical Concentration (mg/Kg)	Ingestion Rate (mg/Day) Annual Avg.	Conversion Factor 10^{-6} Kg/mg	Fraction Ingested From Contaminated Source	Exposure Frequency (Days)	Exposure Duration (Years)	1/Body Weight	1/Averaging Time	Chronic Daily Intake mg/Kg-Day
Vinyl Chloride	ND @ Surface	100	10^{-6}	1	365	70 years	1/70 kg	1/25,550	---
TCE	0.043 <0.019>	100	10^{-6}	1	365	70 years	1/70 kg	1/25,550	6×10^{-7} <2.7×10^{-7}>
1,2-DCE	ND @ Surface	100	10^{-6}	1	365	70 years	1/70 kg	1/25,550	---
1,1,1 TCA	0.140	100	10^{-6}	1	365	70 years	1/70 kg	1/25,550	2×10^{-6}
Cr	4,420 <24>	100	10^{-6}	1	365	70 years	1/70 kg	1/25,550	6.3×10^{-3} <3.4×10^{-5}>
Cu	5,010 <44.1>	100	10^{-6}	1	365	70 years	1/70 kg	1/25,550	7.16×10^{-3} <6.3×10^{-5}>
Ni	34.60 <12.9>	100	10^{-6}	1	365	70 years	1/70 kg	1/25,550	4.9×10^{-3} <1.85×10^{-5}>
Zn	844 <47.4>	100	10^{-6}	1	365	70 years	1/70 kg	1/25,550	1.2×10^{-3} <6.78×10^{-5}>
Pb	60 <16.8>	100	10^{-6}	1	365	70 years	1/70 kg	1/25,550	8.57×10^{-5} <2.4×10^{-5}>

ChemicalConcentration Maximum Measured Concentration reported in boldface
< > Indicates Reasonably Expected Maximum Concentration

(

TABLE 6.8

Residential Exposure: Ingestion of Chemicals in Soil by Older Child
(Maximum Measured Concentration)

Chemical	Chemical Concentration (mg/Kg)	Ingestion Rate (mg/Day) Annual Avg.	Conversion Factor 10^{-6} Kg/mg	Fraction Ingested From Contaminated Source	Exposure Frequency (Days)	Exposure Duration (Years)	1/Body Weight	1/Averaging Time	Chronic Daily Intake mg/Kg-Day
Vinyl Chloride	0.068	24	10^{-6}	1	365	4 years	1/20.8 Kg	1/25,550	4.48×10^{-9}
TCE: Surface	0.043	24	10^{-6}	1	365	4 years	1/20.8 Kg	1/25,550	2.83×10^{-9}
Subsurface	5.7								3.76×0^{-6}
1,2-DCE	**0.140**	**24**	**10^{-6}**	**1**	**365**	**4 years**	**1/20.8 Kg**	**1/25,550**	**9.23×10^{-9}**
1,1,1 TCA	**0.140**	**24**	**10^{-6}**	**1**	**365**	**4 years**	**1/20.8 Kg**	**1/25,550**	**9.23×10^{-9}**
Cr	**4,420** **<24.0>**	**24**	**10^{-6}**	**1**	**365**	**4 years**	**1/20.8**	**1/25,550**	**2.43×10^{-5}** **<1.32×10^{-4}>**
Cu	**5,010** **<44.1>**	**24**	**10^{-6}**	**1**	**365**	**4 years**	**1/20.8**	**1/25,550**	**3.3×10^{-4}** **<2.4×10^{-4}>**
Ni	**34.60** **<12.9>**	**24**	**10^{-6}**	**1**	**365**	**4 years**	**1/20.8**	**1/25,550**	**2.28×10^{-6}** **<7.1×10^{-5}>**
Zn	**844** **<47.4>**	**24**	**10^{-6}**	**1**	**365**	**4 years**	**1/20.8**	**1/25,550**	**5.56×10^{-5}** **<2.6×10^{-4}>**
Pb	**60** **<16.8>**	**24**	**10^{-6}**	**1**	**365**	**4 years**	**1/20.8**	**1/25,550**	**3.96×10^{-6}** **<9.24×10^{-5}>**

ChemicalConcentration Maximum Measured Concentration reported in boldface
< > Indicates Reasonably Expected Maximum Concentration

Table 6-9

TABLE 6.10

RESIDENTIAL EXPOSURE

OCCASIONAL INGESTION OF CHEMICALS IN SURFACE WATER WHILE SWIMMING

CHEMICAL	CHEMICAL CONCENTRATION mg/L	CONTACT RATE	EXPOSURE TIME	EXPOSURE FREQUENCY	EXPOSURE DURATION	1/BODY WEIGHT	1/AVERAGING TIME	INTAKE mg/kg-day
Aluminum	5.3	50ml/Hr	2.5 Hr.	7 days/year	70 years	1/70kg	1/365.70	0.036
Cr III	**0.038** **<0.017>**	**50ml/Hr**	**2.5 Hr.**	**7 days/year**	**70 years**	**1/70 kg**	**1/365.70** **<5.8x10^{-6}>**	**1.6x10^{-5}**
CU	0.021 <0.016>	50ml/Hr.	2.5 Hr.	7 days/year	70 years	1/70 kg	1/365.70	7.2x10^{-6} <5.48x10^{-6}>
ZN	0.016 <0.012>	50ml/Hr.	2.5 Hr.	7 days/year	70 years	1/70 kg	1/365.70	5.5x10^{-6} <4.1x10^{-6}>

TABLE 6.11

Residential Exposure: Dermal Contact with Chemicals in Soil

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

Chemical	Chemical Concentration	Conversion Factor	Skin Surface Area	Skin to Soil Adhesive Factor	Absorption Factor	Exposure Frequency	Exposure Duration	1/Body Weight	1/ Averaging Time	Absorbed Dose (mg/kg-day)
Chromium	**4,420** <24.0>	10^{-6}	1.94	2.77	1	80	70 yrs.	1/70 kg	1/70 yrs. x 365 days/year	1.1×10^{-3} $<6.1 \times 10^{-4}>$
Copper	**5,010** <44.1>	10^{-6}	1.94	2.77	1	80	70 yrs.	1/70 kg	1/70 yrs. x 365 days/year	1.3×10^{-3} $<1.1 \times 10^{-5}>$
Zinc	**844** <47.4>	10^{-6}	1.94	2.77	1	80	70 yrs.	1/70 kg	1/70 yrs. x 365 days/year	2.1×10^{-4} $<1.2 \times 10^{-5}>$
Nickel	**34.60** <12.9>	10^{-6}	1.94	2.77	1	80	70 yrs.	1/70 kg	1/70 yrs. x 365 days/year	8.9×10^{-4} $<3.3 \times 10^{-4}>$
Lead	**60** <16.8>	10^{-6}	1.94	2.77	1	80	70 yrs.	1/70 kg	1/70 yrs. x 365 days/year	1.5×10^{-5} $<4.3 \times 10^{-4}>$

ChemicalConcentration **Maximum Measured Concentration** reported in boldface
< > Indicates Reasonably Expected Maximum Concentration

Discussion of the variables and assumptions used in calculations; assumed, worst-case or actual site-measured exposure concentrations; and the estimated chemical intake values for each pathway judged complete for the site are presented in the following sections.

Dermal Contact with Surface Soils

Estimated intakes presented below were based upon 95th percentile values for contact rates and exposure frequency variables. A soil absorption factor of 1 was used. Area of exposed skin was assumed was to be 50th percentile of total body surface (1.94 m^2); a soil to skin adherence factor of 2.77 and exposure frequency of 121 days (equivalent to eight hours of daily exposure on an annual basis) for a 70 year duration.

Chronic Daily Intake (mg/kg-day)

	Adult	
Chemical	RME	MS
Chromium	6.1E-03	1.1E-03
Copper	1.1E-05	1.3E-03
Nickel	3.3E-06	8.9E-06
Zinc	1.2E-05	2.1E-04
Lead	4.3E-06	1.57E-05

Ingestion of Chemicals in Surface Soil

Exposure frequency of 365 days per year for a lifetime duration were used in the risk calculations. Average ingestion rates of 100 mg/day for adults and 200 mg/day for children were used in the estimate calculations.

Estimated chronic daily intake values for incidental ingestion of site soils at the surface by adults and the older child that were calculated based on the geometric mean of sample concentrations as the reasonably expected maximum exposure (RME) concentration and maximum sample (MS) concentration measured in site soils are presented below:

Chronic Daily Intake (mg/kg-day)

	Adult		**Child**	
Chemical	RME	MS	RME	MS
Trichloroethylene	2.7E-07	6.0E-07		2.38E-07
1,1,1-Trichloroethane		2E-06		
Chromium	3.4E-04	6.3E-02	1.3E-04	2.45E-03
Copper	6.3E-04	7.2E-02	2.4E-04	2.8E-02
Nickel	1.85E-04	4.9E-02	7.1E-05	1.92E-04
Zinc	6.8E-04	1.2E-02	2.6E-04	4.6E-03
Lead	2.4E-04	8.57E-04	9.25E-05	3.3E-04

Ingestion of Chemicals in Surface Water While Swimming

An ingestion rate of 50 ml, and a figure of 7 days (national average) of swimming activity was used in the calculation of risk factors presented below. An exposure time variable of 2.5 hours and a 70 year lifetime duration period.

Estimated chronic daily intake values for incidental ingestion of surface water by an adult individual were calculated based on the geometric mean of sample concentrations as the reasonably expected maximum exposure (RME) and maximum sample (MS) concentrations measured in surface waters residing in the target pond are presented below:

Estimated Chronic Daily Intake (mg/kg-day)

Chemical	Adult RME	Adult MS
Chromium (III)	5.8E-08	1.6E-05
Copper	5.5E-08	7.2E-08
Zinc	4.1E-08	5.5E-08

Ingestion of Chemicals in Drinking Water

An ingestion rate of 2 l/day (90th confidence level) was used in the calculation with an exposure frequency of 365 days per year over a 70 year lifetime period.

Estimated chronic daily intake values for incidental ingestion of groundwater for the adult individual were calculated based on 1) the geometric mean of sample concentrations as the reasonably expected maximum exposure (RME) concentration and 2) maximum sample (MS) concentrations measured. These values are presented below for contaminants found in the shallow and intermediate aquifers:

Estimated Chronic Daily Intake (mg/kg-day)

	Shallow Aquifer		Intermediate Aquifer	
Chemical	RME	MS	RME	MS
Vinyl Chloride		3.1E-02	Not Detected	
Trichloroethylene		1.9E-03	Not Detected	
Chromium (III)	6.4E-04	1.3E-03	5.2E-04	6.0E-04
Copper	2.8E-03	1.9E-03	Not Detected	
Nickel				
Zinc	3.1E-04	6.3E-04	Not Detected	

6.3 Toxicity Assessment

All reference dose and slope factor values used in the risk characterization process were obtained from one of the following approved sources: the USEPA Integrated Risk Information System

Database, the Health Effects Assessment Summary Tables (Fourth Quarter, FY 1989) and toxicological profiles from the Agency for Toxic Substances and Disease Registry.

Additionally, Techna Corporation contacted the USEPA's Environmental Criteria and Assessment Office (ECAO) for technical guidance concerning oral route to dermal route extrapolation and toxicity values for dermal contact and to verify the whether the most appropriate reference dose and slope factors were located from the above reference sources.

6.3.1 Toxicity Effects: Non-Carcinogenic Effects

Information concerning the critical effects for non-carcinogenic inorganic and volatile organic site-related chemicals, reference dose and reference dose basis, uncertainty factors, and modifying factors are presented in Tables 6-12 and 6-13. A general overview of the health effects associated with the non-carcinogenic site-related chemicals are described in the following sections.

A general overview of the health effects associated with the non-carcinogenic site-related chemicals are described in the following sections. Pertinant information was obtained from Cassarett and Doull's Toxicology, The Basic Science of Poisons, Second Edition, Macmillan Publishing Company, New York, New York, 1980 for all chemicals of concern with the exception of 1,2-dichloroethene wherein the ATSDR Toxiclogical Profile for 1,2-dichloroethene was relied upon for toxicity information.

Chromium

Chromium exists in several valence states. Only the trivalent and hexavalent are biologically significant. The conversion of hexavalent to trivalent does not take place in the body. Trivalent chromium is an essential element in animals and chromium supplementation improves or normalizes glucose tolerance in diabetics, older people, and malnourished children.

TABLE 6.12

TOXICITY VALUES
POTENTIAL NON-CARCINOGENIC HEALTH EFFECTS
INORGANICS

CHEMICAL	ORAL CHRONIC R_fD (mg/kg-day)	CONFIDENCE LEVEL	CRITICAL EFFECT	R_fD/BASIS SOURCE	UNCERTAINTY & MODIFYING FACTORS
Oral Route Aluminum	Data Inadequate for Quantitative Rist Assessment Health Effects Assessment Summary Tables 4th Quarter Fiscal Year 1989				
Chromium III	1E+D	Low	NOEL	IRIS	H,A,S,L UF=100 MF=10
IV	5E-3	Low	Cancer	IRIS	H,A, UF=500 MF=1
Copper	$3.70x10^2$			ATSDR	
	1.3mg/l(MCL)			HEAST	
Nickel	$2x10^2$	Medium		IRIS/Diet	UF=100 MF=3
Silver	$3.00x10^{-3}$			IRIS	
	0.05mg/l MCL			HEAST	
Zinc	$2.1x10^{-1}$			HEAST	UF=10
Lead	$1.4x10^{-3}$			ATSDR	
	ND			IRIS	

TABLE 6.13

TOXICITY VALUES FOR NON-CARCINOGENIC EFFECTS

VOLATILE ORGANICS

CHEMICAL	CHRONIC R_fD	CONFI-DENCE LEVEL	CRITICAL EFFECT	R_fD BASIS/ SOURCE	UNCERTAINTY & MOBILITY FACTORS
Oral Route					
1,1,1 TCA	$2x10^{-2}$			HEAST	
	0.09mg/kg-day			ATSDR	
t-1,2 Dichloro-ethylene	Long Term DW HEA 1.43 mg/L Child 5.0 mg/L Adult			ATSDR	
t-1,2 Dichloro-ethylene	$2.0x10^{-2}$			HEAST	

The total chromium body burden of man has been estimated at less than 6 mg. The major environmental exposure to chromium occurs as a consequence of its presence in food. The daily intake has been estimated at 60 ug(30 to 100 ug), 10 ug of which is due to 10 ug. However, absorption is limited to approximately 1 percent.

Water-soluble chromates disappear from the lungs into the circulatory system after intratracheal application, while the trivalent chromic chloride remains in the lungs. Oral administration of trivalent chromium results in little chromium absorption. The degree of absorption is slightly higher following administration of hexavalent compounds. Once absorbed, the trivalent chromium ion is bound to the plasma proteins.

Occupational expsoure to chromium compounds (hexavalent chromium) causes dermatitis, penetrating ulcers on the hands and forearms, perforation of the nasal spetum, and inflammation of the larynx and liver. Epidemiologic studies indicate that chromate is a carcinogen with bronochogenic carcinoma as the principal lesion. The latent period appears to be 10 to 15 years. Studies have been performed to show that incorporation of hexavalent chromium into the drinking water of mice over their lifetimes produced a slightly higher incidence of malignant tumors than in the controls. Trivalent chromium given to rats under similar conditions showed no such effect.

Copper

Copper is widely distributed in nature and is an essential element. Oxidative enzymes, such as catalase, peroxidase, cytochrome oxides, and others, also require copper. The intestinal mucosa acts to some extent as a barrier to the absorption of ingested copper. Information exists abouth the absorption of copper following inhalation exposure is not complete, and the data on the absorpiton of copper through the skin are limited. Most cuprous salts are insoluble in water but they tend to oxidize in the cupric form. Most cuprous salts are insoluble in water but they tend to oxidize to the cupric form. The bile is the normal excretory pathway and plays a primary role in copper homestasis. The liver and bone marrow are the storage organs for excess copper. Man is less sensitive to copper than other mammals, presumably because of a better-developed homeostatic mechanism.

Acute poisoning resulting from accidental ingestion of excessive amounts of oral copper salts, most frequently copper sulfate, may produce death. Long-term exposure of humans to copper by inhalation, oral, and dermal routes occurs in occupational settings.

Nickel

Nickel is a constituent of urban air, possibly as a result of fossil fuel combustion. Nickel is not a normal constituent of water. Relatively large amounts occur naturally in vegetables, legumes and grains.

The average body burden of nickel has been estimated at <10 mg. Nickel is present present in the lung, liver kidney and intestine of most stillborn infants. The concentration in the lung increases with age; ncikel has been found in the bile. Excretion is largely via the feces. A mechanism for limiting intestinal absorption has been suggested. Many nickel salts have astringent and irratant properties which limit their absorption.

Dermatitis is the most frequent effect of exposure to nickel. Nickel carbonyl is the most toxic of nickel compounds. It has been estimated to lethal to man at atmospheric exposures of 30 ppm for 20 minutes. Chronic exposure to nickel carbonyl has been implicated epidemiologically in cancer affecting lung and nose.

Zinc

Zinc is ubiquitious and is considered an essential trace element. Its necessary roles involve enzymes and enzymatic functions, protein synthese, and carbohydrate metabolism. It is necessary for normal growth and development in mammals and birds.

Zinc is omnipresent in the environment being found in water, in air, and in all living organisms. Normally, the muscle, liver, kidney,and pancreas contain large amounts. The eyes also have large concentrations. The zinc in blood is largely contained in the red blood cells.

Zinc is elimnated principally by the gastrointestinal tract. The pancreatic fluids contain significant amounts, while additional quantities are found in the bile. The urine contains significantly less than the feces.

Accidental oral poisioning has been reported in humans as aresult of consuming acidic food or beverages from galvanized containers. The symptoms of such intoxications consist of fever, vomiting, stomach cramps, and diarrhea. Industrial exposures occur as a result of inhalation of freshly formed fumes of zinc oxide. Only the freshly formed material is potent, presumably because of flocculation n the air, thereby preventing deep penetration into the lungs. Dermal toxicity following exposures to $ZnCl_2$ has resulted from consistently handling these salts.

Attempts to produce zinc toxicity by incorporating as much as 25 percent in the diet of rats have not been successful. At levels above this the homeostatic mechanism breaks done: growth retardation, and defective mineralization of the bone occur.

Lead

There are two forms of lead - inorganic lead in which the various salts and oxides are considered to act as identically once absorbed into the systemic circulation and alkyl lead which rapidaly dealkylated by the liver to the trialkyl metabolites that are resposible for toxicity. The trialkyl metabolites are then only slowly metabolized to inorganic lead.

Major routes of exposure include gastrointestinal tract and the respiratory system.
The absorption of lead from the gastrointestinal tract is greatly influenced by concurrent dietary levels of numerous substances, notably calcium, iron, fats, and proteins. Absorption also is considerably greater in infants than in adults and during the fasting state than with meals.

Approximately 90 percent of the total body burden of lead with long-term exposures is in the bones. No other striking affinities exist, althogh liver and kidney have somewhat higher than average concentrations. Excretion of lead occurs by way of the bile and urine and by exfoliation of epithelial tissue, including hair.

Biological effects include central nervous effects such as lead encephalopathy; renal effects involving damage to the proximal tublules, interstitial fibrosis, sclerosis of vessels, and glomeral atrophy of the kidney. Lead encephalopathy is a severe, often fatal condition, with features such as dullness, restlessness, headaches, loss of memory, occurring as a result of chronic or subchronic exposure to high doses of inorganic lead. Subtle behavioral effects, particularly in children, at levels of expsoure below those causing encephalopathy, may cause deficits as reflected in psychometric performance tests and certain neurologic tests.

1,1,1-Trichloroethane

1,1,1-Trichloroethane (Methyl Chloroform) has received received widespread acceptance as an industrial solvent. It has a depressant action on the central nervous system. 1,1,1-trichloroethane is partially metabolized to trichlroethanol and to a less extent to trichloroacetic acid.

Experimental human exposures to 500 ppm of methyl chloroform for 6.5 to 7 hours per day for five days gave no evidence of abnormal organ function as measured by a variety of clinical laboratory tests. In experimental animals, near lethal doses of 1,1,1-trichloroethane are required to produce a measurable hepatoxic response to a single dose.

1,2-Dichloroethene

cis- and trans-1,2-Dichloroethene are man-made compounds. Sources of 1,2-dichloroethene environmental exposure include: process and fugitive emissions from its production and use as a chemical intermediate, formation via anaerobic biodegradation of some chlorinated solvents and leaching from landfills.

Clinical symptons that have been reported in humas expsoed to 1,2-dichloroethene in air include nausea, drowsiness, fatiques, intracranial pressure and ocular irritation. Concentration of cis- and trans-1,2-dichloroethene in air that is lethal to humans is not known. Trans-1,2-dichloroethene is an ocular irritant in humans. No other specific systemic effects have been reported in humans.

6.3.2 Toxicity Effects: Carcinogenic Effects

Information concerning the type of cancer, slope factors, weight of evidence, slope factor basis and source for carcinogenic site-related chemicals is presented in Table 6-14. A general overview of the health effects associated with the carcinogenic site-related chemicals are described in the following sections.

Trichloroethylene

Overexposure to trichloroethylene produces central nervous system depression resulting in mental confusion, incoordination, and insomnia. Other effects include increased liver and kidney weights, severe changes in the cerebellum and changes in Punrinje cell layers of dogs. Metabolic byproducts of trichloroethylene include trichloroacetic acid, trichloroethanol, and small amounts of chloroform and monochloroacetic acid. Trichloroethylene has a rather long biologic half-life.

Animal toxicity studies involving oral exposure to mice have shown that at low and high dose levels, in both sexes, there was a highly significant increase in hepatocellular carcinomas; inhalation of trichloroethylen vapor produces pulmonary carcinomas. Based on this evidence, trichloroethylene is classified as a Probable Human Carcinogen (Group B2).

Vinyl Chloride

Vinyl chloride is considered to have a low order of acute toxicity. Central nervous system depression will occur when animals and man are exposed to moderately high levels of the gas.

Vinyl chloride is classified by the Carcinogen Assessment Group of the USEPA
as a Group A Human Carcinogen. It has been shown to be carcinogen in rats, mice and hamsters. Following oral and inhalation exposures, vinyl chloride has produced a high incidence of liver, kidney, lung and brain tumors in the aforementioned animals.

No information is available on the teratogenicity of vinyl chloride following oral exposures. Inhalation exposures have not led to significant embryonal or fetal toxicity or gross teratogenic abnormalities.

6.4 Risk Characterization

Health risks potentially posed by site-related contaminants were quantitatively evaluated as appropriate for the following pathways: dermal contact with surface soil, incidental ingestion of surface soil, occasional ingestion of surface water by swimmers and ingestion of groundwater. For each pathway analyzed, risk calculations were performed to quantify risk posed for both carcinogenic and non-carcinogenic effects. Chronic daily intakes were calculated using exposure concentrations for each chemical used in the risk calculations were include: 1) the geometric mean of all sample concentrations for each media sampled (or the reasonable maximum expected concentration) and 2) the maximum measured concentration in the medium sampled (for the volatile organic chemicals and those inorganics with low frequency of detection in a specific medium).

6.4.1 Site Cancer Risk Estimates

For carcinogens, risks are estimated as the incremental possibility of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen. Carcinogenic risk estimates are generally an upper-bound estimate, since many assumptions that tend to be overprotective are used in the risk evaluation process (e.g., chemicals found to be carcinogenic in animals are assumed to be carcinogenic in humans, carcinogens are considered as having non-threshold effects and to pose some level of risk at all exposure levels). Site-related chemicals identified as carcinogens include trichloroethylene and vinyl chloride. Trichloroethylene was detected in site soils (in the RST and UVWYXZ grid areas which lie beneath asphalt paving and are located adjoining to and northeast and southwest of the building) and in the groundwater in the shallow saturated zone. Vinyl chloride was detected only in the groundwater of the shallow saturated zone.

Table 6-15 presents a summary of the cancer risk estimates that were calculated for chemical-specific risks, total pathway risk and total site exposure risk (an additive risk for all carcinogens encountered at the site) for each of the site-related chemicals that are known carcinogens. Current use of the site would preclude exposure to the shallow aquifer and the contaminated soils. Pathways considered for the cancer risk evaluations were based upon alternate future potential use of the site and are described as follows:

TABLE 6.14

TOXICITY VALUES FOR POTENTIAL CARCINOGENIC SITE RELATED CHEMICALS

CHEMICAL	SLOPE FACTOR	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF SOURCE	SF BASIS
Vinyl Chloride	2.3EO	A	Lung	IRIS	Diet
TCE	1.1E-2	B2	Liver	IRIS	Diet
1,1,1 TCA		D		HEAST	
Lead	ND	B2		HEAST	
Silver		D		HEAST	

TABLE 6.15

CANCER RISK ESTIMATES

Chemical	CDI	CDI Adjusted For Absorption	Slope Factor	Weight of Evidence	Type of Cancer	SF Source	SF Basis	(CDI x SF) Chemical Specific Risk	Total Pathway Risk	Total Exposure Risk
<u>Ingestion of GW</u>										
Vinyl Chloride	0.031	No	2.3E 0	A	Lung	Iris		7.13×10^{-2}		
Trichloroethylene	1.9×10^{-3}	No	1.1E -2	B2	Liver	Iris		2.09×10^{-5}		
									7.13×10^{-2}	
<u>Ingestion of Soils</u>										
Vinyl Chloride	ND @ Surface									
Trichloroethylene	6×10^{-7}		1.1E -2					6.6×10^{-9}		
										7.13×10^{-2}

Shallow Aquifer Ingestion of Drinking Water	Alternate future potential use of the site may be residential. This pathway is considered as a possible worst case scenario since public health regulations would not permit use of the shallow saturated zone as a potable water source.
Ingestion of Site Soils	Alternate future potential use of the site may be residential with resulting exposure of children and adults.

Vinyl chloride and trichloroethylene were estimated to pose chemical-specific risks equal to 7.1E-02 and 2.1E-05, respectively. Total pathway risk from exposures due to ingestion of groundwater and site soils under alternate future residential use scenarios were estimated to equal 7.1E-02 and 6.6E-09, respectively. Total site exposure was estimated to equal 7.1E-02.

6.4.2 Non-Carcinogens: Potential Health Effects Risk Estimates

Table 6-16 presents a summary of the chronic hazard indices that quantified chemical-specific risk, total pathway risk and total site exposure (additive and across all pathways) for non-carcinogenic site-related chemicals. Pathways considered for the chronic hazard risk evaluations performed were based upon alternate future potential residential use of the site and include the following: ingestion of groundwater and site soils, ingestion of surface water while swimming, and dermal contact with site soils. As shown in Table 6-16, hazard indices (the cumulative sum of the hazard quotients or ratio of estimated intake concentration to reference dose) were found to be below unity for all pathways except for ingestion of site soils. Hazard quotients for exposure to copper and nickel in site soils were estimated to equal 1.9 and 2.45 respectively.

6.4.3 Risk Quantitation

The National Contingency Plan (NCP) recognizes the existence of insignificant levels of risk, or acceptable levels of exposure which are adequately protective of human health and the environment. For known or suspect carcinogens, acceptable exposure levels are generally concentrations levels that represent an excess upper bound risk range of 1E-04 to 1E-06 (40 CFR Part 300 Section 300.430 (e) (2)). For determining the extent of protectiveness, the NCP considers that the target total carcinogenic risks to the individual resulting from exposures at a Superfund site may range from anywhere from 1E-04 to 1E-06, with risk levels of 10E-06 as the point of departure. Selection of

TABLE 6-16

CHRONIC HAZARD RISK ESTIMATES

Chronic Non-Carcinogenic Hazard Quotient = Estimate Intake (mg/kg-day)/R_fD (mg/kg-day)

EXPOSURE PATHWAY CHEMICAL	INGESTION OF CONTAMINATED WELL WATER (ADULT)	INGESTION OF CHEMICALS IN SURFACE WATER WHILE SWIMMING (ADULT)	INCIDENTAL INGESTION OF CHEMICALS IN SOIL (ADULT)	(CHILD)	DERMAL CONTACT WITH SURFACE SOIL
Chromium	Shallow **$1.29x10^{-3}$** <6.4X10-4>	**$1.6x10^{-5}$** <5.8X10-8>	**$6.3x10^{-2}$**	**$2.56x10^{-1}$**	$1.1x10_{-3}$
	Intermediate **6x10-4** $<5.2x10^{-4}>$		<3.4x10-4>	<1.32x10-4>	**<6.1x10-6>**
Copper	**$7.6x10^{-2}$** $<5.13x10^{-2}>$	**$7.19x10^{-8}$** $<1.48x10^{-8}>$	**1.9** $<1.7x10^{-2}>$	**$2.56X10^{-1}$** <6.4x10-3>	**$3.5X10^{-2}$** <2.97x10-8>
Nickel	ND	ND	**2.45** $<9.2x10^{-3}>$	**$9.6x10^{-3}$** $<3.5x10^{-3}>$	9.45x10-4 $<1.6x10^{-4}>$
Zinc	**$2.99x10^{-3}$** $<1.48x^{-3}>$	**$5.5x10^{-8}$** $<1.95x10^{-7}>$	**$5.7x10^{-2}$** $<3.23x10^{-3}>$	**$2.19x10^{-2}$** $<1.23x10^{-3}>$	**$1.0x10^{-3}$** $<5.7x10_{-5}>$
Lead	ND	ND	**$6.12x10^{-3}$** $<1.7x10^{-3}>$	**$2.3x10^{-3}$** $<6.6x10^{-4}>$	**$1.07x10^{-1}$** $<3.07x10^{-5}>$
1,2 DCE	$5.5x10^{-1}$	NS	ND at Surface	ND at Surface	
1,1,1TCA	ND	NS	**$2.2x10^{-5}$**	**$8.8x10^{-6}$**	ND at Surface
Pathway Index	**$5.8x10^{-1}$** $<5.68x10^{-1}>$	**$1.6x10^{-5}$** $<1.73x10^{-6}>$	**4.48** $<3.15x10^{-2}>$	**$7.9x10^{-1}$** $<1.2x10^{-2}>$	**$1.4x10^{-1}$** $<2.5x10^{-4}>$

ND = Not Detected
NS = Not Samples

Total Exposure Index: 5.2 (Maximum Exposure Point Concentrations)
$5.9x10^{-1}$ (Maximum Reasonably Expected Concentrations

remedies will be towards those that are at the protective end of this range. Remedial alternatives being considered should be able to reduce total carcinogenic risks to individuals to levels within this range, except where exceptional circumstances warrant more stringent cleanups.

For non-carcinogens, risks are estimated based upon the possibility of a dose-related toxicological effect occurring with exposure. Exposure levels are compared over a specified period with the time-related reference dose (dose determined not to cause an adverse effect) to develop a hazard quotient (e.g., risk index). If the total hazard index is greater than one, evaluation of the hazard for target organ effect is necessary. If the hazard still exceeds one, potential health hazards may be unacceptable.

For comparative purposes, Table 6-17 presents the maximum exposure concentrations measured in site groundwaters for the site-related chemicals, applicable Maximum Contaminant Levels, and drinking water concentrations corresponding to the reference dose for non-carcinogenic site-related chemicals. Table 6-18 presents the cancer risk per ug/l, cancer risk associated with the maximum exposure point concentration, and Maximum Contaminant Levels for those carcinogenic site-related chemicals.

The estimated risk associated with the presence of vinyl chloride in the shallow aquifer contributes significantly to the overall magnitude for estimated total cancer exposure risk. The pathway risk for the site through ingestion of drinking water of 7.13E-02. The chemical specific risk for trichloroethylene by this pathway was estimated to equal to 2.09E-05. Total pathway cancer risk due to incidental ingestion of site soils is based only upon exposure to trichloroethylene, since vinyl chloride was not detected in site soils, and was calculated to equal 6.6E-09.

Total exposure index for the site from non-carcinogens is equal to 6.1E-01 based upon intake estimates derived using reasonably expected maximum contaminant levels. The presence of 1,2-dichloroethene in the groundwater determines the overall magnitude of this value. The estimated chronic hazard quotient for 1,2-dichloroethylene is 5.15E-01.

Using maximum measured concentrations for the site-related chemicals in each media (worst case scenario) and assuming alternate future potential residential use of the site, the total chronic hazard index score for the site is estimated to equal 5.85.

TABLE 6.17

DRINKING WATER STANDARDS AND R_fD DRINKING WATER EQUIVALENT LEVELS
NON-CARCINOGENIC CHEMICALS OF CONCERN

CHEMICAL	CRQL CRDL	DRINKING WATER R_fD EQUIVALENT CONCENTRATION	MAXIMUM EXPOSURE CONCENTRATION	RATIO MAXIMUM ESPOSURE CONCENTRATION TO R_fD_{DW}		MAXIMUM CONTAMINANT LEVEL (mg/l)
Chromium	7 ug/l	III 35 mg/l VI 1.75×10^{-2}	Shallow 0.045 Intermediate 0.021	1.28×10^{-3} 1.1×10^{-2}		0.10 mg/L
Copper	10 ug/l	1.29×10^{0}	0.099	7.67×10^{-2}		1.3 mg/l
Nickel	11 ug/l	7.0×10^{-1}	ND	---		---
Lead		4.9×10^{-2}		5.1×10^{-2}		5.0
Zinc	6 ug/l	7.35×10^{0}	0.022	2.99×10^{-3}		

TABLE 6-18

CANCER RISKS ASSOCIATED WITH INGESTION OF CONTAMINATED GROUNDWATER

CHEMICAL	CRQL CRDL	CANCER RISK PER ug/l	CANCER RISK AT CRQL or CRDL	MAXIMUM MEASURED CONCEN-	CANCER RISK AT MAXIMUM EXPOSURE PT.	MAXIMUM CONCEN-TRATION
Trichloroethylene	5 ug/l	$3.14x10^{-7}$	$1.57x10^{-6}$	1,100 ug/l	Shallow Aquifer $3.45x10^{-3}$	0.005 mg/l
1,1,1 Trichloroethane	5 ug/l					0.200 MCL 0.02 MCLG
Vinyl Chloride	10 ug/l	$6.57x10^{-4}$	$6.57x10^{-3}$	68 ug/l	Shallow Aquifer $4.4x10^{-2}$	0.002
Dichloroethylene (Total)	5 ug/l					cis 0.07 trans 0.07

6.5 Environmental Risk Assessment

6.5.1 Objective of the Assessment

The objective of this environmental assessment is to determine if contaminants originating from the Hi-Mill Manufacturing Company pose a threat of actual and/or potential risk to both biotic and abiotic components on the study site and/or to peripheral areas surrounding the area of concern.

6.5.2 Scope of the Assessment

One objective of this environmental assessment is to evaluate the actual and/or potential pathways of the migration of contaminants from the contaminant source and to determine the actual and/or potential receptors both on-site and in the immediate vicinity of the study area. Subsequently, these pathways of exposure will be analyzed to determine damage to the environment that could result from
exposure to these contaminants.

The assessment procedure for the study site consisted of relevant methodologies for the sampling and subsequent testing of groundwater, local soils, surface waters and associated sediments for the contaminants of interest as described in Sections 1 - 4 and Section 6.2 of this report.

6.5.3 Site/Study Area Description

A geographical and historical overview of the Hi-Mill Manufacturing site study area is presented in Section 1.2 of this document. The Target Wetland, Waterbury Lake, and terrestrial areas surrounding these features and the Hi-mill facility are the primary concern and will comprise the focus of this environmental assessment.

Species of interest in the assessment area would include aquatic free-swimming organisms, aquatic benthic organisms, and terrestrial species (vertebrates and invertebrates) found in the transition zone between marsh-like conditions and upland areas. Some species of birds that typically nest in these environments, such as the red-winged blackbird, as well as migratory species of water fowl, such as ducks and geese, may also be exposed to the contaminants of concern. Vegetation which could be impacted by the species of concern are also of interest; these species may suffer direct harm or serve as a pathway for indigenous herbivorous animal species.

A survey was conducted of the study site in April of 1984 by the Water Quality Surveillance Section of the Michigan Department of Natural Resources (Appendix O). The aquatic ecosystem under investigation was sampled to assess the diversity of both floral and faunal species, and a list of observations was then compiled to summarize the findings.

The diversity and numbers of faunal species identified in the 1984 survey was very low. Ponar grab samples of the local sediments produced only midges, a ubiquitous aquatic insect; no other benthic aquatic insects, insect larvae or macroinvertebrates were identified in the sediment samples. This limited population of bottom-dwelling organisms may be related to seasonal fluctuations of the water levels of the marsh, seasonal freezing of the shallow water, or possibly by a combination of several other environmental conditions.

One species of daphnids, an aquatic free-swimming invertebrate, was identified in abundance at one sampling site, and a fish, believed to be a mud-minnow, was sighted as well.

The diversity and numbers of floral species identified was much more impressive, and included a variety of algaes, macrophytes and numerous periphyton. Algaes identified included Spirogyra, Euglena, Scenedesmus, Oocystis, Oscillatoria, Mougeotia and Synedra. Macrophytes identified included Typha, Scirpus, Lemna minor, Elodea and Potamogeton. Much periphyton was noted at several sampling sites coating much of the substrate.

The average measured depth (rough measurement performed during the RI) of the wetland area under investigation was between six and eight feet deep. This relatively shallow depth certainly precludes any recreational use such as boating, swimming, etc. Also, from a seasonal perspective, a complete freeze-through would be expected during the winter months, followed by elevated water temperatures during the summer months with a concomitant depletion of the dissolved oxygen concentration in the surface waters. Such drastic seasonal variations in the chemical and physical parameters of the wetland area are probably responsible for the relatively low diversity of indigenous biota.

6.5.4 Contaminants of Concern

The contaminants of concern for the various media under investigation include elevated concentrations of several TAL metals species. These contaminants were identified as a concern in this environmental risk assessment primarily by statistical inference. An average value (mean), standard deviation and mean plus two standard deviations from the mean were calculated for the background media samples. Therefore, subsequent samples collected and analyzed were then assessed as problematic if they contained contaminants at levels above the statistical criteria established by the background contaminant levels.

The primary contaminants of concern for the surface waters of the wetland area are aluminum, copper and trivalent chromium; no hexavalent chromium was detected in any of the samples. The primary contaminants of concern for the sediments are four metals of interest including aluminum, trivalent chromium, zinc, and copper. The contaminants of concern for the soils on the Hi-Mill site are numerous inorganics including aluminum, barium, calcium, chromium, copper, iron, magnesium, nickel, potassium, vanadium and zinc.

Volatile chlorinate solvents were measured in soil samples from the small assessment are (grid RST-01234) located south of the Hi-Mill production building. However, since solvent contamination of soils is limited to this area, and this area is paved, TCL volatiles are not contaminants of concern for this environmental risk assessment.

6.5.5 Exposure Pathways

This section of the environmental risk assessment will identify the potential biological fate of the hazardous materials of interest, namely, the aforementioned TAL metals. The elements of the indigenous biological community that are the actual and/or potential target populations for these contaminants include both aquatic and terrestrial floral and faunal components.

Both aquatic plants and animals are particularly sensitive to assimilating higher levels of hazardous environmental pollutants because they are stantly immersed in the contaminated water medium under investigation. It is commonly assumed that the body tissue contaminant concentration of aquatic species seeks equilibrium with the levels of contaminant concentration of the ambient body of water. The rate of uptake and the amount of contaminant assimilation is highly dependent on both the nature of the contaminant and on the species of the organism as well. Of particular interest when assessing the bioavailability of heavy metals in aquatic ecosystems is the relationship of other physical and chemical parameters, such as organic content, pH and water hardness.

Little data is available to quantify the effect of the contaminant concentration of metals in the body tissue of aquatic or terrestrial animal species relative to the ambient environmental concentrations of the contaminants. Most research to date has focused on the bioaccumulation of organic, lipid-soluble substances in the body fat (lipids) of terrestrial organisms, as well as in the hepatic and pancreatic organ tissues of various biota. Since these contaminants are of no concern in the surface water, sediments, or soils in this investigation, a discussion of food-chain enhancement is irrelevant. Also, it has been demonstrated that heavy metals such a those present at this study site, do not represent a threat to higher trophic levels of terrestrial organisms since they do not typically biomagnify at higher trophic levels in the food chain.

Contaminant uptake by terrestrial plants has been extensively studied, but almost exclusively from a perspective of the human consumption of edible cash crops such as vegetables and grains. Therefore, little, if any, data to adequately assess contaminant uptake by naturally occurring, native vegetation; therefore, comment will be limited to the fact that only physical sampling and analyses of plant tissues over time would adequately address this concern.

Terrestrial and burrowing animals may also come into contact with the inorganic contaminants; the primary route of exposure would be the direct dermal contact with the contaminated soils. The uptake of metals by organisms via this mode of exposure would be expected to be minimal, if any.

6.5.6 Risk Characterization

This section of the environmental assessment will characterize the actual and/or potential risk to biological receptors at the study site. The risk to indigenous biota in this ecosystem of study is in the marsh water and associated sediments, as well as surrounding soils. Due to the obvious dearth of both the diversity and the numbers of individuals per species represented, the risks associated with the heavy metal contaminants are probably minimal.

Historically, heavy metals, as trace elements in biotic ecosystems are important in plant and animal nutrition where they play an essential role as micronutrients in tissue metabolism and organism growth. Requirements differ substantially for plants and animals; severe imbalances can cause death, whereas marginal imbalances contribute to poor health, retarded growth and/or reproductive disorders. The marsh, associated sediments, and surrounding soils in this study site are experiencing anthropogenic enrichment of several trace metals originating from the Hi-Mill Manufacturing operation. The question is whether this inorganic enrichment is detrimental and/or lethal to the native biotic community of this ecosystem.

To characterize the risk to the environment by the contaminants of concern, it is prudent to examine relevant established criteria. Sources of information researched for this environmental risk assessment include "Toxicological Profiles" as published by the Agency For Toxic Substances and Disease Registry (ATSDR) of the U.S. Public Health Service, and also a computer-accessed database of the "Toxnet" system called "Integrated Risk Information System" (I.R.I.S.)

Unfortunately, these sources primarily address the risk associated with environmental contaminants in the context of human health concerns. Therefore, relevant information to adequately address the various environmental media for this risk assessment are minimal. No established standards could be located to judge both soils and sediments; only a limited amount of information could be found to assess surface waters. Table 6-17 presents a guide to the ambient surface water quality criteria as established by the U.S. Environmental Protection Agency, juxtaposed with the maximum detected value of a given contaminant identified in the surface water samples. All values are reported in micrograms per liter (ug/l). In no case does the reported maximum sample value for any dissolved contaminant under investigation exceed these established guidelines; the contaminants of concern are not a threat to the wetland ecosystem.

TABLE 6-17

COMPARISON OF HIGHEST DETECTED LEVELS OF SURFACE WATER CONTAMINANTS TO USEPA AMBIENT WATER QUALITY CRITERIA

Contaminant	Maximum Detected Level ($\mu g/l$)	Ambient Water Quality Criteria ($\mu g/l$)
Al	<CRDL	Not Available
Cr^{+3}	38.5	59,000
Cr^{+6}	<MDL	50
Cu	21.4	1000
Ag	11.4	Not Available
Zn	16.2	5000

APPENDIX A

SURFACE WATER SAMPLE MASTER DATA TABLE

SURFACE WATER MASTER FILE

ATIONNO	SAMPLEID	ENCOTECNO	SAMCOLDATE	FEETEAST	FEETNORTH	ELEVATION	SAMPLETYPE
P01	HMW-BP01	E48376	03/01/90	4888.91	2735.58	993.70	SLM, NPN, CR6
P02	HMW-BP02	E48377	03/01/90	4823.19	2517.57	993.70	SLM, NPN, CR6
P03	HMW-BP03	E48378	03/01/90	5050.62	558.89	993.70	SLM, NPN, CR6
P04	HMW-BP04	E48379	03/01/90	4921.42	2287.57	999.61	TAL Ino, NPN, CR6
P01	HMW-TP01	E48405	03/02/90	4589.98	6237.97	1005.06	SLM, CR6
P02	HMS-TP02	E48406	03/02/90	5199.43	6341.68	1005.80	TAL Ino, CR6
P02	HMW-TP02-FB	E48413	03/02/90	5199.43	6341.68	1005.80	CR6
P04	HMW-TP04	E48407	03/20/90	49446.76	6394.91	1005.65	SLM, CR6
P04	HMW-TP04-D	E48408	03/02/90	49446.76	6394.91	1005.65	CR6
P04	HMW-TP04-FB	E48414	03/02/90	49446.76	6394.91	1005.65	SLM
P07	HMW-TP07	E48409	03/02/90	5144.51	5699.19	1005.71	TAL Ino, NPN, CR6
P07	HMW-TP07-D	E48410	03/02/90	5144.51	5699.19	1005.71	TAL Ino, NPN
P07	HMW-TP07-FB	E48415	03/02/90	5144.51	5699.19	1005.71	NPN
P09	HMW-TP09	E48404	03/02/90	5724.70	5464.78	1005.75	SLM, CR6
P10	HMW-TP10	E48401	03/02/90	5383.06	5991.93	1005.63	SLM, CR6, NPN
P10	HMW-TP10-D	E48402	03/02/90	5383.06	5991.93	1005.63	SLM, CR6
P11	HMW-TP11	E48411	03/02/90	5172.76	5482.82	1005.67	TAL Ino, CR6
P11	HMW-TP11-D	E48412	03/02/90	5172.76	5482.82	1005.67	TCN
P11	HMW-TP11-FB	E48416	03/02/90	5172.76	5482.82	1005.67	TAL Ino
LO1	HMW-WL01	E48399	03/02/90	6154.04	4870.93	999.31	SLM, CR6
L02	HMW-WL02	E48400	03/02/90	4850.46	4666.79	1000.19	SLM, CR6, NPN
TP-10	HMW-TP10FB		3/02/90	5383.06	5991.93	1005.63	CR6

APPENDIX B

SEDIMENT SAMPLE MASTER DATA TABLE

SEDIMENTS MASTER FILE

STATIONNO	SAMPLEID	ENCOTECNO	SAMCOLDATE	FEETEAST	FEETNORTH	ELEVATION	SAMPLETYPE
BP01	HMS-BP01-0	E48010	02/24/90	4888.91	2735.58	993.70	SLM, CR5
BP02	HMS-BP02-0	E48011	02/21/90	4823.19	2517.57	993.70	SLM, CR6
BP03	HMS-BP03-0	E48012	02/21/90	5050.60	2558.89	993.70	SLM, CR6
BP04	HMS-BP04-0	E48013	02/21/90	4921.42	2287.57	999.61	TAL Ino, CR6
BP2	HMS-BP2-0	E48011	02/22/90	0.00	0.00	0.00	
TP01	HMS-TP01-0	E48017	02/21/90	4589.98	6237.97	1005.06	SLM, CR6
TP01	HMW-TP01-0D	E48018	02/21/90	4589.98	6237.97	1005.06	SLM
TP02	HMW-TP02-0	E48092	02/22/90	5199.43	6341.68	1005.80	TAL Ino, CR6
TP03	HMS-TP03-0	E48091	02/22/90	5209.03	6394.91	1006.69	SLM, CR5
TP04	HMS-TP04-0	E48019	02/21/90	49446.76	6394.91	1005.65	SLM, CR6
TP04	HMS-TP04-1	E48020	02/21/90	49446.76	6394.91	1005.65	SLM, CR6
TP05	HMS-TP05-0	E47962	02/20/90	5496.99	5864.93	1005.65	SLM, CR6
TP06	HMS-TP06-0	E48021	02/21/90	5049.77	5790.81	1005.68	SLM, CR6
TP06	HMS-TP06-1	E48022	02/21/90	5049.77	5790.81	1004.18	SLM, CR6
TP07	HMS-TP07-0	E48093	02/22/90	5144.51	5699.19	1005.71	TAL Ino, CR6
TP07	HMS-TP07-1	E48094	02/22/90	5144.51	5699.19	1005.71	SLM, CR6
TP07	HMS-TP07-1D	E48095	02/22/90	5144.51	5699.19	1005.71	SLM, CR6
TP08	HMS-TP08-0	E48096	02/22/90	5207.15	5520.58	1005.75	SLM, CR6
TP08	HMS-TP08-1	E48097	02/22/90	5207.15	5520.58	1005.75	TAL Ino, CR6
TP08	HMS-TP08-1D	E48101	02/22/90	5207.15	5520.58	1005.75	TAL Ino
TP09	HMS-TP09-0	E47963	02/20/90	5724.70	5464.78	1005.75	SLM, CR5
TP10	HMS-TP10-0	E47964	02/20/90	5383.06	5991.93	1005.63	SLM, CR5
TP11	HMS-TP11-0	E48098	02/22/90	5172.76	5482.82	1005.67	SLM, CR6
TP11	HMS-TP11-1	E48099	02/22/90	5172.76	5482.82	1005.67	SLM, CR5
TP11	HMS-TP11-1D	E48100	02/22/90	5172.76	5482.82	1005.67	CR6
TP12	HMS-TP12-0	E48944	03/14/90	0.00	0.00	0.00	SLM, CR6
WL01	HMW-WL01-0	E48014	02/21/90	6154.05	4870.93	999.31	SLM, CR5
WL02	HMW-WL02-0	E48015	02/21/90	4850.46	4666.79	1000.19	SLM, CR6
WL02	HMW-WL02-0D	E48016	02/21/90	4850.46	4666.79	1000.19	SLM, CR6

APPENDIX C

SOIL SAMPLE MASTER DATA TABLE

SOILS MASTER

SAMPLE ID	ENCOTEC NUMBER	BORING TYPE	SAMPLE COLLECTION DATE	FEET EAST	FEET NORTH	ELEVATION	SAMPLE DEPTH	DEPTH BELOW SURFACE	SOIL TYPE	SAMPLE TYPE
HMS-A1-0	E46462	NTYPEII	01/24/90	4819.81	5011.05	1009.4	1	0.0	SDC	SLM
HMS-A1-1	E46463	NTYPEII	01/04/90	4819.81	5011.05	1006.1	3	3.3	CSD	SLM
HMS-A2-0	E46464	NTYPEII	01/24/90	4879.25	5006.78	1011.0	1	0.0	SDC	SLM
HMS-A2-1	E46465	NTYPEII	01/24/90	4879.25	5006.78	1005.0	3	6.0	CST	SLM
HMS-A3-0	E46466	NTYPEII	01/24/90	4940.20	5006.44	1010.6	1	0.0	CT	SLM
HMS-A3-1	E46467	NTYPEII	01/24/90	4940.20	5006.44	1008.1	3	2.5	STC	SLM
HMS-A4-0	E46502	SOF	01/24/90	5000.00	5000.01	996.8	1	0.0	CT	SLM
HMS-B1-0	E46468	NTYPEII	01/24/90	4812.45	5067.17	1009.4	1	0.0	SDT	SLM
HMS-B1-0D	E46469	NTYPEII	01/24/90	4812.45	5067.17	1009.4	1	0.0	SDT	SLM
HMS-B1-1	E46470	NTYPEII	01/24/90	4812.45	5067.17	1006.6	3	2.8	CSD	SLM
HMS-B2-0	E46471	NTYPEII	01/24/90	4883.03	5063.26	1010.6	1	0.0	SDC	SLM
HMS-B2-1	E46472	NTYPEII	01/24/90	4883.03	5063.26	1007.4	3	3.2	SDC	SLM
HMS-B3-0	E46473	NTYPEII	01/24/90	4939.49	5061.15	1011.9	1	0.0	SDT	SLM
HMS-B3-1	E46474	NTYPEII	01/24/90	4939.49	5061.15	1008.2	3	3.7	STC/LB	SLM
HMS-B4-0	E46503	SOF	01/24/90	5001.36	5059.87	1010.4	1	0.0	CT	SLM
HMS-B5-0	E46504	SOF	01/24/90	5061.31	5060.98	1010.8	1	0.0	CT	SLM
HMS-B5-0D	E46505	SOF	01/24/90	5061.31	5060.98	1010.8	1	0.0	CT	SLM
HMS-C1-0	E46475	NTYPEII	01/24/90	4823.72	5123.51	1009.5	1	0.0	SDC	SLM
HMS-C1-1	E46476	NTYPEII	01/24/90	4823.72	5123.51	1008.5	3	1.0	STC	SLM
HMS-C2-0	E46589	NTYPEII	01/26/90	4884.89	5122.52	1010.6	1	0.0	STC	SLM
HMS-C2-1	E46590	NTYPEII	01/26/90	4884.89	5122.52	1008.1	3	2.5	STC	SLM
HMS-C3-0	E46591	NTYPEII	01/26/90	4945.03	5121.31	1011.2	1	0.0	STC	SLM
HMS-C3-0D	E46592	NTYPEII	01/26/90	4945.03	5121.31	1011.2	1	0.0	STC	SLM
HMS-C3-1	E46593	NTYPEII	01/26/90	4945.03	5121.31	1008.2	3	3.0	STC/LB	SLM
HMS-C4-0	E46506	SOF	01/24/90	5003.28	5120.13	1010.0	1	0.0	CT	TAL Ino
HMS-C5-0	E46507	SOF	01/24/90	5062.99	5119.19	1009.9	1	0.0	CT	SLM
HMS-D2-0	E46594	NTYPEII	01/26/90	4867.75	5192.22	1010.1	1	0.0	STC	SLM
HMS-D2-1	E46595	NTYPEII	01/26/90	4867.75	5192.22	1006.8	3	3.3	STC/LB	SLM
HMS-D3-0	E47380	NTYPEII	02/07/90	4956.89	5181.44	1009.6	1	0.0	CT	SLM
HMS-D3-1	E47381	NTYPEII	02/07/90	4956.89	5181.44	1007.3	3	2.3	STC	SLM
HMS-D4-0	E46508	SOF	01/24/90	5004.22	5179.96	1009.8	1	0.0	CT	SLM
HMS-D5-0	E46509	SOF	01/24/90	5063.86	5178.06	1009.5	1	0.0	SDT	SLM
HMS-D6-0	E46510	SOF	01/24/90	5124.57	5176.67	1009.8	1	0.0	SDT	SLM
HMS-E2-0	E46597	NTYPEII	01/26/90	4886.55	5240.53	1010.0	1	0.0	STC	SLM
HMS-E2-1	E46596	NTYPEII	01/26/90	4886.55	5240.53	1007.5	3	2.5	STC	SLM
HMS-E3-0	E46598	NTYPEII	01/26/90	4945.51	5241.37	1010.2	1	0.0	STC	SLM
HMS-E3-1	E46599	NTYPEII	01/26/90	4945.51	5241.37	1007.2	3	2.5	STC	SLM
HMS-E4-0	E46511	SOF	01/24/90	5006.24	5239.77	1009.2	1	0.0	SDT	SLM
HMS-E5-0	E46512	SOF	01/24/90	5066.08	5238.42	1009.2	1	0.0	CT	TAL Ino
HMS-E6-0	E46513	SOF	01/24/90	5125.89	5237.13	1009.2	1	0.0	SDT	SLM
HMS-E7-0	E46514	SOF	01/24/90	5186.68	5235.86	1010.0	1	0.0	CT	SLM
HMS-F3-0	E46601	NTYPEII	01/26/90	4948.40	5300.71	1009.2	1	0.0	STC	SLM
HMS-F3-0D	E46600	NTYPEII	01/26/90	4948.40	5300.71	1009.2	1	0.0	STC	SLM
HMS-F3-1	E46602	NTYPEII	01/26/90	4948.40	5300.71	1006.2	3	3.0	STC	SLM
HMS-F4-0	E46892	NTYPEII	02/01/90	5007.69	5304.85	1009.0	1	0.0	STSD	SLM
HMS-F4-1	E46893	NTYPEII	02/01/90	5007.69	5304.85	1005.5	3	3.5	STC	SLM
HMS-F5-0	E46515	SOF	01/24/90	5066.08	5238.42	1009.8	1	0.0	SDT	SLM
HMS-F6-0	E46516	SOF	01/24/90	5127.34	5297.21	1009.0	1	0.0	CT	SLM
HMS-F7-0	E46517	SOF	01/24/90	5188.22	5295.25	1008.0	1	0.0	CT	SLM
HMS-F7-0D	E46518	SOF	01/24/90	5188.22	5295.25	1008.0	1	0.0	CT	SLM
HMS-F8-0	E46521	SOF	01/24/90	5247.66	5293.97	1007.3	1	0.0	CT	SLM
HMS-G3-0	E46603	NTYPEII	01/26/90	4952.46	5362.35	1009.0	1	0.0	CT	SLM
HMS-G3-1	E46604	NTYPEII	01/26/90	4952.46	5362.35	1004.0	3	5.0	OSTC	SLM
HMS-G3/H4-0	E46428	TypeII	01/23/90	4989.71	5386.86	1009.9	1	0.0	CSD	SLM

SOIL TYPE: P=PEAT CT=CLAYEY TOPSOIL SDT=SANDY TOPSOIL OSTC=ORGANIC SILTY CLAY STC=SILTY CLAY SDC=SANDY CLAY STC/LB=SILTY CLAY WITH SAND OR SILT LAMINA, LENZES OR BEDS CST=CLAYEY SILT CSD=CLAYEY SAND STSD=SILTY SAND SD=SAND SDG=SANDY GRAVEL

SOILS MASTER

SAMPLE ID	ENCOTEC NUMBER	BORING TYPE	SAMPLE COLLECTION DATE	FEET EAST	FEET NORTH	ELEVATION	SAMPLE DEPTH	DEPTH BELOW SURFACE	SOIL TYPE	SAMPLE TYPE
HMS-G3/H4-1	E46429	TypeII	01/23/90	4989.71	5386.86	1006.9	2	3.0	SD	SLM
HMS-G3/H4-2	E46430	TypeII	01/23/90	4989.71	5386.86	998.9	3	11.0	SD	Tal Ino
HMS-G3/H4-3	E46431	TypeII	01/23/90	4989.71	5386.86	995.9	4	14.0	STC	SLM
HMS-G4-0	E47174	TypeII	02/05/90	5015.19	5386.09	1010.1	1	0.0	SDT	SLM
HMS-G4-1	E47175	TypeII	02/05/90	5015.19	5386.09	1007.6	2	2.5	STSD	SLM
HMS-G4-2	E47176	TypeII	02/05/90	5015.19	5386.09	998.8	3	11.3	STSD	Tal Ino, Tcl Cr
HMS-G4-2D	E47177	TypeII	02/05/90	5015.19	5386.09	998.8	3	11.3	STSD	Tal Ino
HMS-G4-3	E47178	TypeII	02/05/90	5015.19	5386.09	995.1	4	15.0	STC/LB	SLM
HMS-G5-0	E46432	NTYPEII	01/23/90	5069.13	5358.98	1008.6	1	0.0	CSD	SLM
HMS-G5-2	E46433	NTYPEII	01/23/90	5069.13	5358.98	1003.1	3	5.5	STC	SLM
HMS-G6-0	E46349	TypeII	01/22/90	5129.31	5357.11	1007.9	1	0.0	CSD	SLM
HMS-G6-1	E46351	TypeII	01/22/90	5129.31	5357.11	1005.4	2	2.5	CSD	SLM
HMS-G6-2	E46352	TypeII	01/22/90	5129.31	5357.11	1004.9	3	3.0	CSD	SLM
HMS-G6-3	E46350	TypeII	01/22/90	5129.31	5357.11	1001.9	4	6.0	STC	SLM
HMS-G7-0	E46519	SOF	01/24/90	5188.72	5359.49	1006.0	1	0.0	CT	TAL Ino
HMS-G8-0	E46520	SOF	01/24/90	5249.32	5353.70	1006.1	1	0.0	CT	SLM
HMS-H3-0	E47382	NTYPEII	02/07/90	4950.51	5421.36	1008.0	1	0.0	SD	SLM
HMS-H3-0D	E47383	NTYPEII	02/07/90	4950.51	5421.36	1008.0	1	0.0	SD	SLM
HMS-H3-1	E47384	NTYPEII	02/07/90	4950.51	5421.36	1003.7	3	4.3	SD	SLM
HMS-H3/I3-0	E48435	NTYPEII	03/04/90	4913.59	5448.75	1007.9	1	0.0	SD	SLM
HMS-H3/I3-1	E48436	NTYPEII	03/04/90	4913.59	5448.75	1001.1	3	6.8	SD	SLM
HMS-H3/I4-1	E47272	TypeII	02/06/90	4975.43	5449.83	1001.7	2	6.0	SD	SLM
HMS-H3/I4-2	E47273	TypeII	02/06/90	4975.43	5449.83	996.9	3	10.8	STC	Tal Ino
HMS-H3/I4-3	E47274	TypeII	02/06/90	4975.43	5449.83	991.7	4	16.0	STC/LB	SLM
HMS-H4-0	E48437	NTYPEII	03/04/90	5007.76	5419.45	1010.0	1	0.0	SDT	SLM
HMS-H4-1	E48438	NTYPEII	03/04/90	5007.76	5419.45	1003.5	3	6.5	STSD	SLM
HMS-H4/I5-0	E47164	TypeII	02/05/90	5042.62	5453.99	1007.3	1	0.0	CT	SLM
HMS-H4/I5-1	E47165	TypeII	02/05/90	5042.62	5453.99	1004.8	2	2.5	CT	SLM
HMS-H4/I5-2	E47166	TypeII	02/05/90	5042.62	5453.99	1002.0	3	5.3	STC	Tal Ino
HMS-H4/I5-3	E47167	TypeII	02/05/90	5042.62	5453.99	998.3	4	9.0	STC/LB	SLM
HMS-H5-0	E46894	NTYPEII	02/01/90	5070.67	5420.46	1007.9	1	0.0	SDT	SLM
HMS-H5-1	E46895	NTYPEII	02/01/90	5070.67	5420.46	1004.2	3	3.7	STC/LB	SLM
HMS-H6-0	E46344	TypeII	01/22/90	5129.59	5416.24	1007.2	1	0.0	SD	SLM
HMS-H6-0D	E46345	TypeII	01/22/90	5129.59	5416.24	1007.2	1	0.0	SD	SLM
HMS-H6-1	E46346	TypeII	01/22/90	5129.59	5416.24	1004.7	2	2.5	STC	SLM
HMS-H6-2	E46347	TypeII	01/22/90	5129.59	5416.24	1003.0	3	4.2	CSD	SLM
HMS-H6-3	E46348	TypeII	01/22/90	5129.59	5416.24	1000.2	4	7.0	STC	SLM
HMS-H7-0	E46245	TypeII	01/19/90	5188.57	5412.21	1006.1	1	0.0	CT	SLM
HMS-H7-1	E46246	TypeII	01/19/90	5188.57	5412.21	1003.6	2	2.5	P	SLM
HMS-H7-2	E46247	TypeII	01/19/90	5188.57	5412.21	1000.6	3	5.5	P	SLM
HMS-H7-3	E46248	TypeII	01/19/90	5188.57	5412.21	997.6	4	8.5	STC	SLM
HMS-H8-0	E47597	SOF	02/09/90	5243.69	5418.14	1005.9	1	0.0	STC	SLM
HMS-I3-1	E47168	TypeII	02/05/90	4949.69	5482.48	1001.5	2	7.0	CSD	SLM
HMS-I3-2	E47169	TypeII	02/05/90	4949.69	5482.48	995.8	3	12.7	CSD	SLM
HMS-I3-3	E47170	TypeII	02/05/90	4949.69	5482.48	992.5	4	16.0	STC/LB	SLM
HMS-I4-1	E47171	TypeII	02/05/90	4988.33	5480.21	1003.8	2	5.0	SD	SLM
HMS-I4-2	E47172	TypeII	02/05/90	4988.33	5480.21	999.6	3	9.2	SDC	Tal Ino, Tcl Cr
HMS-I4-3	E47173	TypeII	02/05/90	4988.33	5480.21	995.8	4	13.0	STC/LB	SLM
HMS-I4-3D	E47179	TypeII	02/05/90	4988.33	5480.21	995.8	4	13.0	STC/LB	SLM
HMS-I5-0	E46424	TypeII	01/23/90	5072.85	5478.63	1007.4	1	0.0	CSD	SLM
HMS-I5-1	E46425	TypeII	01/23/90	5072.85	5478.63	1005.0	2	2.4	STC	SLM
HMS-I5-2	E46426	TypeII	01/23/90	5072.85	5478.63	1001.9	3	5.5	P	SLM
HMS-I5-3	E46427	TypeII	01/23/90	5072.85	5478.63	998.9	4	8.5	STC/LB	SLM
HMS-I6-0	E46339	TypeII	01/22/90	5124.71	5472.53	1006.8	1	0.0	STC	SLM

SOIL TYPE: P=PEAT CT=CLAYEY TOPSOIL SDT=SANDY TOPSOIL OSTC=ORGANIC SILTY CLAY STC=SILTY CLAY SDC=SANDY CLAY
STC/LB=SILTY CLAY WITH SAND OR SILT LAMINA, LENZES [illegible] BEDS CST=CLAYEY SILT CSD=CLAYEY SAND STSD=SILTY SAND SD=SAND
SDG=SANDY GRAVEL

SOILS MASTE E

SAMPLE ID	ENCOTEC NUMBER	BORING TYPE	SAMPLE COLLECTION DATE	FEET EAST	FEET NORTH	ELEVATION	SAMPLE DEPTH	DEPTH BELOW SURFACE	SOIL TYPE	SAMPLE TYPE
HMS-I6-0D	E46340	TypeII	01/22/90	5124.71	5472.53	1006.8	1	0.0	STC	SLM
HMS-I6-1	E46341	TypeII	01/22/90	5124.71	5472.53	1004.3	2	2.5	OSTC	SLM
HMS-I6-2	E46342	TypeII	01/22/90	5124.71	5472.53	1001.2	3	5.6	CSD	SLM
HMS-I6-3	E46343	TypeII	01/22/90	5124.71	5472.53	998.3	4	0.0	STC	SLM
HMS-I7-0	E47688	NTYPEII	02/13/90	5188.61	5474.89	1005.9	1	0.0	OSTC	SLM
HMS-I7-1	E47689	NTYPEII	02/13/90	5188.61	5474.89	1004.4	3	1.5	STSD	SLM
HMS-I8-0	E47687	SOF	02/12/90	5247.34	5483.20	1005.9	1	0.0	OSTC	SLM
HMS-J5-0	E46335	TypeII	01/22/90	5080.46	5527.23	1006.6	1	0.0	SDT	SLM
HMS-J5-1	E46336	TypeII	01/22/90	5080.46	5527.23	1004.1	2	2.5	CSD	SLM
HMS-J5-2	E46337	TypeII	01/22/90	5080.46	5527.23	1003.1	3	1.5	CSD	SLM
HMS-J5-3	E46338	TypeII	01/22/90	5080.46	5527.23	999.6	4	0.0	STC	SLM
HMS-J6-0	E47690	NTYPEII	02/13/90	5133.52	5535.53	1005.9	1	0.0	P	SLM
HMS-J6-1	E47691	NTYPEII	02/13/90	5133.52	5535.53	1004.4	3	1.5	STC	SLM
HMS-J6-1D	E47692	NTYPEII	02/13/90	5133.52	5535.53	1004.4	3	1.5	STC	SLM
HMS-J7-0	E47686	SOF	02/12/90	5192.41	5532.29	1005.9	1	0.0	OSTC	SLM
HMS-K3-0	E46902	NTYPEII	02/01/90	4956.34	5603.77	1009.1	1	0.0	CT	SLM
HMS-K3-1	E46903	NTYPEII	02/01/90	4956.34	5603.77	1004.5	3	4.6	STC	SLM
HMS-K4-0	E46896	NTYPEII	02/01/90	5013.97	5598.45	1008.0	1	0.0	CSD	SLM
HMS-K4-0D	E46897	NTYPEII	02/01/90	5013.97	5598.45	1008.0	1	0.0	CSD	SLM
HMS-K4-1	E46898	NTYPEII	02/01/90	5013.97	5598.45	1005.0	3	3.0	STC	SLM
HMS-K5-0	E46901	SOF	02/01/90	5075.06	5598.40	1006.1	1	0.0	CT	SLM
HMS-K6-0	E47685	SOF	02/12/90	5132.08	5597.81	1005.9	1	0.0	P	SLM
HMS-L3-0	E46899	NTYPEII	02/01/90	4958.30	5662.52	1007.3	1	0.0	CT	SLM
HMS-L3-1	E46900	NTYPEII	02/01/90	4958.30	5662.52	1004.8	3	2.5	CSTC	SLM
HMS-L3-1D	E46904	NTYPEII	02/01/90	4958.30	5662.52	1004.8	3	2.5	OSTC	SLM
HMS-L4-0	E47693	SOF	02/12/90	5015.25	5661.36	1006.0	1	0.0	OSTC	TAL Ino
HMS-L5-0	E47694	SOF	02/12/90	5073.59	5661.59	1006.0	1	0.0	CSTC	SLM
HMS-M3-0	E47595	SOF	02/09/90	4958.39	5722.19	1005.9	1	0.0	CSTC	SLM
HMS-M4-0	E47596	SOF	02/09/90	5015.68	5721.08	1005.9	1	0.0	OSTC	SLM
HMS-OG1-0	E47385	SOF	02/09/90	5289.44	5358.10	1006.2	1	0.0	CT	TAL Ino
HMS-OG2-0	E47386	SOF	02/09/90	5182.39	5155.11	1010.3	1	0.0	CT	TAL Ino
HMS-OG3-0	E47387	SOF	02/09/90	4965.49	4982.59	1010.5	1	0.0	CT	TAL Ino
HMS-OG4-0	E47388	SOF	02/09/90	4801.42	4964.70	1008.4	1	0.0	CT	TAL Ino
HMS-RS01-0	E46654	SWGrid	01/29/90	4758.43	5166.13	1009.4	1	0.3	SDG	TCL VOA, SLM
HMS-RS01-2	E46655	SWGrid	01/29/90	4758.43	5166.13	1008.6	3	1.1	STC/LB	TCL VOA, SLM
HMS-RS01-2D	E46666	SWGrid	01/29/90	4758.43	5166.13	1008.6	3	1.1	STC/LB	TCL VOA
HMS-RS01-3	E46656	SWGrid	01/29/90	4758.43	5166.13	1005.4	4	4.0	STC	TCL VOA, SLM
HMS-RS12-0	E46657	SWGrid	01/29/90	4769.54	5164.26	1009.2	1	0.5	SDG	TCL VOA, SLM
HMS-RS12-3	E46658	SWGrid	01/29/90	4769.54	5164.26	1005.7	4	4.0	STC	TCL VOA, SLM
HMS-RS23-0	E46659	SWGrid	01/29/90	4779.54	5163.95	1009.5	1	0.3	SDG	TCL VOA, SLM
HMS-RS23-1	E46660	SWGrid	01/29/90	4779.54	5163.95	1007.3	3	2.5	SDC	TCL VOA, SLM
HMS-RS23-3	E46661	SWGrid	01/29/90	4779.54	5163.95	1004.3	4	5.5	STC	TCL VOA, SLM
HMS-RS23-3D	E46662	SWGrid	01/29/90	4779.54	5163.95	1004.3	4	5.5	STC	SLM
HMS-RS34-0	E46663	SWGrid	01/29/90	4790.05	5163.60	1009.1	1	0.5	SDG	TCL VOA, SLM
HMS-RS34-2	E46664	SWGrid	01/29/90	4790.05	5163.60	1007.1	3	2.5	STC	TCL VOA, SLM
HMS-RS34-3	E46665	SWGrid	01/29/90	4790.05	5163.60	1004.1	4	5.5	STC/LB	TCL VOA, SLM
HMS-ST01-0	E46687	SWGrid	01/30/90	4759.80	5174.56	1009.3	1	0.5	SDG	TCL VOA, SLM
HMS-ST01-3	E46688	SWGrid	01/30/90	4759.80	5174.56	1006.3	4	3.5	STC	TCL VOA, SLM
HMS-ST12-0	E46689	SWGrid	01/30/90	4769.80	5174.25	1009.3	1	0.5	SDG	TCL VOA, SLM
HMS-ST12-3	E46690	SWGrid	01/30/90	4769.80	5174.25	1005.8	4	4.0	STC/LB	TCL VOA, SLM
HMS-ST12-3D	E46688	SWGrid	01/30/90	4769.80	5174.25	1005.8	4	4.0	STC/LB	TCL VOA
HMS-ST23-0	E46692	SWGrid	01/30/90	4779.79	5173.95	1009.3	1	0.5	SDG	TCL VOA, SLM
HMS-ST23-0D	E46707	SWGrid	01/30/90	4779.79	5173.95	1009.3	1	0.5	SDG	SLM
HMS-ST23-2	E46693	SWGrid	01/30/90	4779.79	5173.95	1007.1	3	2.7	CSD	TCL VOA, SLM

SOIL TYPE: P=PEAT CT=CLAYEY TOPSOIL SDT=SANDY TOPSOIL OSTC=ORGANIC SILTY CLAY STC=SILTY CLAY SDC=SANDY CLAY
STC/LB=SILTY CLAY WITH SAND OR SILT LAMINA, LENZES OR BEDS CST=CLAYEY SILT CSD=CLAYEY SAND STSD=SILTY SAND SD=SAND
SDG=SANDY GRAVEL

SOILS MASTER

SAMPLE ID	ENCOTEC NUMBER	BORING TYPE	SAMPLE COLLECTION DATE	FEET EAST	FEET NORTH	ELEVATION	SAMPLE DEPTH	DEPTH BELOW SURFACE	SOIL TYPE	SAMPLE TYPE
HMS-ST23-3	E46694	SWGrid	01/30/90	4779.79	5173.95	1003.8	4	6.0	STC/LB	TCL VOA, SLM
HMS-ST34-0	E46695	SWGrid	01/30/90	4789.79	5173.64	1009.1	1	0.5	SDG	TCL VOA, SLM
HMS-ST34-2	E46696	SWGrid	01/30/90	4789.79	5173.64	1007.8	3	1.8	STC	TCL VOA, SLM
HMS-ST34-3	E46697	SWGrid	01/30/90	4789.79	5173.64	1004.9	4	4.7	STC/LB	TCL VOA, SLM
HMS-WV01-0	E46801	NEGrid	01/31/90	4828.44	5474.02	1008.5	1	0.5	SDC	TCL VOA, SLM
HMS-WV01-1	E46802	NEGrid	01/31/90	4828.44	5474.02	1007.0	2	2.5	SDC	TCL VOA, SLM
HMS-WV01-2	E46803	NEGrid	01/31/90	4828.44	5474.02	1003.3	3	5.7	CSD	TCL VOA, SLM
HMS-WV01-3	E46804	NEGrid	01/31/90	4828.44	5474.02	1000.3	4	8.7	STC/LB	TCL VOA, SLM
HMS-WV01-3D	E46805	NEGrid	01/31/90	4828.44	5474.02	1000.3	4	8.7	STC/LB	TCL VOA, SLM
HMS-XW01-0	E46797	NEGrid	01/31/90	4827.81	5483.01	1008.8	1	0.3	CSD	TCL VOA, SLM
HMS-XW01-1	E46798	NEGrid	01/31/90	4827.81	5483.01	1007.1	2	2.0	CSD	TCL VOA, SLM
HMS-XW01-2	E46799	NEGrid	01/31/90	4827.81	5483.01	1002.8	3	5.5	CSD	TCL VOA, SLM
HMS-XW01-3	E46800	NEGrid	01/31/90	4827.81	5483.01	999.6	4	9.5	STC	TCL VOA, SLM
HMS-XW12-1	E46819	NEGrid	01/31/90	4839.17	5479.82	1006.0	1	3.0	STC/LB	TCL VOA, SLM
HMS-XW12-2	E46815	NEGrid	01/31/90	4839.17	5479.82	1003.0	3	6.0	STC/LB	TCL VOA, SLM
HMS-XW12-3	E46816	NEGrid	01/31/90	4839.17	5479.82	999.5	4	9.5	STC/LB	TCL VOA, SLM
HMS-YX01-0	E46702	NEGrid	01/30/90	4828.32	5493.09	1008.6	1	0.3	STSD	TCL VOA, SLM
HMS-YX01-1	E46705	NEGrid	01/30/90	4828.32	5493.09	1006.9	2	2.0	STSD	TCL VOA, SLM
HMS-YX01-1D	E46706	NEGrid	01/30/90	4828.32	5493.09	1006.9	2	2.0	STSD	TCL VOA
HMS-YX01-2	E46703	NEGrid	01/30/90	4828.32	5493.09	1003.6	3	5.3	SDC	TCL VOA, SLM
HMS-YX01-3	E46704	NEGrid	01/30/90	4828.32	5493.09	1000.7	4	8.2	SDC	TCL VOA, SLM
HMS-YX12-0	E46806	NEGrid	01/31/90	4835.29	5493.89	1011.4	1	1.0	CSD	TCL VOA, SLM
HMS-YX12-1	E46807	NEGrid	01/31/90	4835.29	5493.89	1010.4	2	2.0	CSD	TCL VOA, SLM
HMS-YX12-2	E46808	NEGrid	01/31/90	4835.29	5493.89	1005.9	3	6.5	STC	TCL Org, SLM
HMS-YX12-3	E46809	NEGrid	01/31/90	4835.29	5493.89	1002.9	4	9.5	STC/LB	TCL VOA, SLM
HMS-YX12-3D	E46810	NEGrid	01/31/90	4835.29	5493.89	1002.9	4	9.5	STC/LB	SLM
HMS-ZY01-0	E46698	NEGrid	01/30/90	4827.56	5502.93	1008.5	1	0.5	SD	TCL VOA, SLM
HMS-ZY01-1	E46699	NEGrid	01/30/90	4827.56	5502.93	1007.0	2	2.0	CSD	TCL VOA, SLM
HMS-ZY01-2	E46700	NEGrid	01/30/90	4827.56	5502.93	1003.0	3	6.0	SDC	TCL VOA, SLM
HMS-ZY01-3	E46701	NEGrid	01/30/90	4827.56	5502.93	1000.0	4	9.0	STC/LB	TCL VOA, SLM
HMS-ZY01-3D	E46708	NEGrid	01/30/90	4827.56	5502.93	1000.0	4	9.0	STC/LB	SLM
HMS-ZY12-0	E46811	NEGrid	01/31/90	4839.12	5505.48	1008.3	1	0.5	CSD	TCL VOA, SLM
HMS-ZY12-1	E46812	NEGrid	01/31/90	4839.12	5505.48	1006.8	2	2.0	CSD	TCL VOA, SLM
HMS-ZY12-1D	E46818	NEGrid	01/31/90	4839.12	5505.48	1006.8	2	2.0	CSD	TCL VOA
HMS-ZY12-2	E46813	NEGrid	01/31/90	4839.12	5505.48	1002.3	3	6.5	STC	TCL VOA, SLM
HMS-ZY12-3	E46814	NEGrid	01/31/90	4839.12	5505.48	998.8	4	10.0	STC/LB	TCL VOA, SLM

SOIL TYPE: P=PEAT CT=CLAYEY TOPSOIL SDT=SANDY TOPSOIL OSTC=ORGANIC SILTY CLAY STC=SILTY CLAY SDC=SANDY CLAY
STC/LB=SILTY CLAY WITH SAND OR SILT LAMINA, LENZES BEDS CST=CLAYEY SILT CSD=CLAYEY SAND STSD=SILTY SAND SD=SAND
SDG=SANDY GRAVEL

BACKGROUND SOILS DATABASE

SAMPLEID	ENCOTECNO	SAMCOLDATE	FEETEAST	FEETNORTH	ELEVATION	SAMP DEPTH	DEPTH BELOW SURFACE	SOILTYPE	SAMPLETYPE
~~HMS-BG1-0~~	~~E47513~~	~~02/08/90~~	~~4210.47~~	~~5258.36~~	~~1016.1~~	~~1~~	~~0.0~~	~~SDT~~	~~TAL Ino, TCL Org~~
HMS-BG1-0D	E47514	02/08/90	4210.47	5258.36	1016.1	1	0.0	SDT	TAL Ino, TCL Org
HMS-BG2-0	E47515	02/08/90	4727.84	5451.94	1005.5	1	0.0	CT	TAL Ino, TCL Org
~~HMS-BG2-1~~	~~E47516~~	~~02/08/90~~	~~4727.84~~	~~5451.94~~	~~1003.0~~	~~2~~	~~2.0~~	~~SDC~~	~~TAL Ino, TCL Org~~
HMS-BG3-0	E47517	02/08/90	5356.13	4787.40	1009.0	1	0.0	SDT	TAL Ino, TCL Org
HMS-BG3-1	E47518	02/08/90	5356.13	4787.40	1006.2	2	2.3	STC	TAL Ino, TCL Org
~~HMS-BG4-0~~	~~E47592~~	~~02/09/90~~	~~6175.22~~	~~5897.00~~	~~1006.3~~	~~1~~	~~0.0~~	~~CT~~	~~TAL Ino, TCL Org~~
HMS-BG4-1	E47593	02/09/90	6175.22	5897.00	1006.3	2	1.0	STC	TAL Ino, TCL Org
HMS-BG5-0	E47594	02/09/90	5957.44	5897.00	1006.3	1	0.0	SDT	TAL Ino, TCL Org
~~HMS-BG5-1~~	~~E48441~~	~~03/05/90~~	~~5957.44~~	~~5897.00~~	~~1001.3~~	~~2~~	~~4.0~~	~~SD~~	~~TAL Ino, TCL Org~~
HMS-BG6-1	E48439	03/05/90	6209.41	5664.14	1002.5	2	4.5	SD	TAL Ino, TCL Org

SOIL TYPE: P=PEAT CT=CLAYEY TOPSOIL SDT=SANDY TOPSOIL OSTC=ORGANIC SILTY CLAY STC=SILTY CLAY SDC=SANDY CLAY STC/LB=SILTY CLAY WITH SAND OR SILT LAMINA, LENZES OR BEDS CST=CLAYEY SILT CSD=CLAYEY SAND STSD=SILTY SAND SD=SAND SDG=SANDY GRAVEL

APPENDIX D

GROUNDWATER SAMPLE MASTER DATA TABLE

GROUNDWATER MASTER FILE

SAMPLEID	ENCOTECNO	AQUIFER	BOSDEPTH	SAMCOLDATE	FEETEAST	FEETNORTH	TOCELEVATI	SAMPLETYPE
HMW-DW01	E49374	Fine Sand	83'0"	03/23/90	4929.12	5078.70	1014.62	SLM TCL VOAS
HMW-DW02	E49306	Fine to Medium Sand	86'6"	03/21/90	4929.12	5502.14	1011.99	SLM, TCL VOAS
HMW-DW02-D	E49307			03/21/90	4929.12	5502.14	1011.99	SLM
HMW-DW02-FB	E49310			03/21/90	4929.12	5502.14	1011.99	TCL VOAS
HMW-DW03	E49701	Silty Sandy Clay w/Seams & Layers Clayey Sand	70'0"	03/23/90	5237.63	5323.86	1009.41	SLM, TCL VOAS
HMW-EW01	E49698		8'1"	03/23/90	4942.94	5703.00	1008.05	SLM, NPN
HMW-EW01-FB	E49699			03/23/90	4942.94	5703.00	1008.05	NPN
HMW-EW02	E49700		7'10"	03/23/90	5052.12	5585.79	1007.33	SLM, NPN
HMW-EW02-D	E49702			03/23/90	5052.12	5585.79	1007.33	SLM
HMW-EW02-D	E49703			03/23/90	5151.44	5449.37	1009.94	SLM, NPN
HMW-EW04	E49703		8'0"	03/23/90	5151.44	5449.37	1009.94	SLM,NPN
HMW-EW04-D	E49704			03/23/90	5151.44	5449.37	1009.94	NPN
HMW-EW04-FB	E49710			03/23/90	5151.44	5449.37	1009.94	NPN
HMW-EW06	E49373		8'0"	03/22/90	5151.44	5449.37	1009.94	SLM, NPN
HMW-EW06-FB	E49696			03/23/90	5151.44	5449.37	1009.94	SLM
HMW-IW01	E49233	Fine Sand	47'0"	03/20/90	4201.32	5224.28	1017.02	TAL INO, TCL Org
HMW-IW02	E49697	Medium to Coarse Sand	46'6"	03/23/90	4930.85	5069.05	1014.56	SLM, TCL VOAS
HMW-IW03	E49309	Coarse Sand	47'6"	03/21/90	4835.32	5498.20	1011.90	TAL Ino, TCL VOAS
HMW-IW04	E49227	Medium Sand	54'0"	03/20/90	4796.28	5657.73	1010.06	SLM, TCL VOAS
HMW-IW05	E49705	Medium to Coarse Sand	35'0"	03/23/90	5242.66	5314.18	1009.39	TAL Ino, TCL VOAS
HMW-SW01	E49167	Silty Clay w/Sand Seams	17'0"	03/19/90	4201.32	5224.28	1013.17	SLM, TCL VOAS, NPN
HMW-SW02	E49168	Fine Silty Sand	28'4"	03/19/90	4195.70	5232.68	1018.04	TAL Ino, TCL Org, NPN
HMW-SW02-D	E49169			03/19/90	4195.70	5232.68	1018.04	TCL Org
HMW-SW02-FB	E49226			03/20/90	4195.70	5232.68	1018.04	TCL Org
HMW-SW03	E49165	Organic Clay w/Sand Lenses	7'0"	03/19/90	4835.29	549.89	1012.43	SLM, TCL VOAS, NPN
HMW-SW04	E49131	Silty Clay	12'6"	03/16/90	4801.81	5856.60	1010.16	SLM, TCL VOAS, NPN
HMW-SW05	E49132	Coarse Sand and Silty Sandy Clay	6'11"	03/16/90	4961.10	5476.12	1011.95	TAL Ino, TCL Org, NPN
HMW-SW05-D	E49133			03/16/90	4961.10	5476.12	1011.95	TCL VOAS
HMW-SW06	E49134	Silty Clay	10'10"	03/16/90	4977.80	5336.34	1011.63	SLM, TCL VOAS, NPN
HMW-SW06-FB	E49135			03/16/90	4977.80	5336.34	1011.63	SLM, TCL VOAS
HMW-SW07	E49141	Silty Clay w/Silt Seams	15'0"	03/17/90	5036.95	5478.99	1010.36	SLM, NPN
HMW-SW07-D	E49142			03/17/90	5036.95	5478.99	1010.36	SLM
HMW-SW08	E49136	Silty Clay w/Sand Seams	10'3"	03/16/90	5108.19	5393.99	1010.85	TAL INO, TCL Org, NPN
HMW-SW08-D	E49137			03/16/90	5108.19	5393.99	1010.85	TAL INO, NPN
HMW-SW08-FB	E49138			03/16/90	5108.19	5393.99	1010.85	TAL INO, NPN
HMW-SW09A	E50719	Silty Clay w/Thin Sand Bed	7'0"	04/12/90	0.00	0.00	1010.88	SLM, NPN
HMW-SW09A-FB	E50720			04/12/90	0.00	0.00	1010.88	NPN
HMW-SW10	E49228	Silty Clay	4'6"	03/20/90	5112.85	5490.56	1010.50	SLM, TCL VOAS, NPN
HMW-SW10-D	E49229			03/20/90	5112.85	5490.56	1010.50	TCL VOAS
HMW-SW11	E49049	Silty Clay w/Medium Sandy Silt Bed	19'0"	03/15/90	4913.90	4918.55	1013.04	SLM, TCL VOAS, NPN
HMW-SW12	E49232	Silty Clay	10'0"	03/20/90	5029.18	5097.04	1013.14	SLM, TCL VOAS, NPN
HMW-SW14	E49231	Silty Clay	16'0"	03/20/90	5247.52	5304.50	1009.76	SLM, NPN
HMW-SW15	E49047	Silty Clay	11'7"	03/15/90	5380.41	5262.08	1010.93	SLM, NPN
HMW-SW17	E49236	Silty Sand	38'6"	03/20/90	5877.47	5286.53	1012.83	SLM, NPN
HMW-SW17-D	E49238			03/20/90	5877.47	5236.53	1012.83	NPN
HMW-SW18	E49237	Silty Sand	14'1"	03/20/90	6150.44	5866.12	1008.58	SLM, NPN
HMW-SW19	E48943	Silty Sand	29'0"	03/14/90	5917.08	6146.97	1015.61	SLM, NH3
HMW-SW20	E49048	Silty Clay	6'0"	03/15/90	5024.45	6420.24	1009.76	SLM, TCL VOAS, NPN
HMW-SW21	E49166	Silty Organic Clay	7'0"	03/19/90	4773.86	5467.87	1012.25	SLM, NPN
HMW-SW22	E49706	Sand and Clay Fill	5'0"	03/25/90	5066.25	5550.10	1010.25	SLM, TCL VOAS, NPN
HMW-SW22-D	E49706			03/23/90	5066.25	5550.10	1010.25	TCL VOAS, TCN
HMW-TB-3/15	E49050			03/15/90	0.00	0.00	0.00	TCL VOA
HMW-TB-3/16	E49139			03/16/90	0.00	0.00	0.00	TCL VOA
HMW-TB-3/19	E49171			03/19/90	0.00	0.00	0.00	TCL VOA

GROUNDWATER MASTER FILE

SAMPLEID	ENCOTECNO	AQUIFER	SOSDEPTH	SAMCOLDATE	FEETEAST	FEETNORTH	TOCELEVATI	SAMPLETYPE
HMW-TB-3/20	E49235			03/20/90	0.00	0.00	0.00	TCL VOA
HMW-TB-3/21	E49311			03/21/90	0.00	0.00	0.00	TCL VOA
HMW-TB-3/22	E49375			03/22/90	0.00	0.00	0.00	TCL VOA
HMW-TB-3/23	E49695			03/23/90	0.00	0.00	0.00	TCL VOA

APPENDIX E

TECHNICAL MEMORANDUM TABLE OF CONTENTS

HI-MILL MANUFACTURING COMPANY
REMEDIAL INVESTIGATION
PHASE I DATA COMPLETENESS

TECHNICAL MEMORANDUM

Prepared by:

Techna Corporation
44808 Helm Street
Plymouth, Michigan 48170

June 1, 1990

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BORING LOGS AND WELL CONSTRUCTION

LOG OF SOIL BORING NO. SW-1

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi Mill Facility

JOB NO. 89-630

LOCATION M-59 & Waterbury

SURFACE ELEV. ______ DATE 11-20-89 Highland Township, Michigan

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
			0'4" Wet gray clayey SAND fill						
	1								
	2								
	3								
	4		Stiff moist brown silty CLAY, with gray & tan silt lenses, plastic						
	5								
A				6					
	6			7					
				9					
	7			13					
	8								
	9								
	10								
B			10'6" Stiff moist blue silty CLAY, with plastic	4					
	11			5					
				8					
	12		11'9" Moist variegated fine silty SAND, well graded	9					
			12'0" Stiff moist blue silty CLAY, with gray silt lenses, seams of wet gray silty sand between 16'6" - 16'9"						
	13								
	14								
	15								
C				2					
	16			3					
				6					
	17		17'0"	5					
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								

TYPE OF SAMPLE
- D. - DISTURBED
- U.L. - UNDIST. LINER
- S.T. - SHELBY TUBE
- S.S. - SPLIT SPOON
- R.C. - ROCK CORE
- ( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT	0 FT.	0 INS.		
G.W. ENCOUNTERED AT	11 FT.	6 INS.		
G.W. AFTER COMPLETION	FT.	INS.		
G.W. AFTER	HRS.	FT.	INS.	
G.W. VOLUMES	Hollow Auger			

McDOWELL & ASSOCIATES
Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. SW-1

Job No. 89-630 Well No. SW-1 Type 2"

Piezometer No. ______

Type and Size of Auger 4½" From 17'0" To Surface

Type and Size of Casing ______ From ______ To ______

Wash Boring With ______ Bit From ______ To ______

Size of Screen .010 Type SS

Bottom of Screen Set At 16'6"

Riser Pipe 2" PVC from 11'6" to surface

Filter No. 3 tan sand From 16'6" To 8'0"

Bentonite ½" pellets From 8'0" To 7'0"

Grout Cement/bentonite From 7'0" To surface

Well Protector 4" steel

Developed With ______

Remarks Top of casing elevation 1,013.17'

LOG OF SOIL BORING NO. SW-2

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi Mill Facility

JOB NO. 89-630

LOCATION M-59 & Waterbury

SURFACE ELEV. ______ DATE 11-13-89 Highland Township, Michigan

Sample type	Depth	Soil Description	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
	0 – 1'0"	Sandy brown TOPSOIL						
	1'0" – 3'0"	Moist oxidized brown fine SAND, with a trace of silt						
	3'0" – 6'0"	Compact moist brown fine SAND, with a trace of silt						
A	5½ – 7		3 4 4 4					
	6'0" – 10'3"	Stiff moist brown clayey SILT						
B	10½ – 12		2 3 2 3					
	10'3" – 15'6"	Medium compact moist tan fine silty SAND						
C	15½ – 17		5 6 8 9					
	15'6" – 18'0"	Compact wet tan fine silty SAND, with seams of clayey silt						
D	19½ – 21		5 6 5 10					
	18'0" – 23'6"	Compact wet tan sandy SILT, with seams of clayey silt						
	23'6" – 25	Compact wet tan fine silty SAND						

TYPE OF SAMPLE
- D. - DISTURBED
- U.L. - UNDIST. LINER
- S.T. - SHELBY TUBE
- S.S. - SPLIT SPOON
- R.C. - ROCK CORE
- ( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT	15	FT.	6	INS.
G.W. ENCOUNTERED AT		FT.		INS.
G.W. AFTER COMPLETION	23	FT.	0	INS.
G.W. AFTER ___ HRS.		FT.		INS.
G.W. VOLUMES	Medium			

Holoow Auger

LOG OF SOIL BORING NO. SW-2 continued

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi Mill Facility

JOB NO. 89-630

LOCATION M-59 & Waterbury

SURFACE ELEV. ______ DATE 11-13-89 Highland Township, Michigan

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
	26		Compact wet tan fine silty SAND						
	27								
	28								
E				6					
	29		29'0"	6					
			Stiff moist blue silty CLAY, with clayey silt	6					
	30			7					
F				5					
	31			4					
				5					
	32		32'0"	4					
	33								
	34								
	35								
	36								
	37								
	38								
	39								
	40								
	41								
	42								
	43								
	44								
	45								
	46								
	47								
	48								
	49								
	50								

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 15 FT. 6 INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION 23 FT. 0 INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES Medium Hollow Auger

McDOWELL & ASSOCIATES
Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. SW-2

Job No. 89-630 Well No. SW-2 Type 2"

Piezometer No. ____

Type and Size of Auger 4¼" From 0 To 30'0"

Type and Size of Casing None From ____ To ____

Wash Boring With None Bit From ____ To ____

Size of Screen .010 Type Stainless

Bottom of Screen Set At 28'4"

Riser Pipe 2" PVC (10' sections)

Filter #3 Tan Sand From 28'4" To 12'10"

Bentonite ¼" Pelletized From 12'10" To 10'4"

Grout ____ From 10'4" To ____

Well Protector 4" Round Steel with hinged cover

Developed With ____

Remarks Top of Casing Elevation 1,018.04

LOG OF SOIL BORING NO. SW-3

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi Mill Facility

JOB NO. 89-630

LOCATION M-59 & Waterbury

SURFACE ELEV.

DATE 11-17-89

Highland Township, Michigan

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
			0'2" ← ASPHALT						
	1		0'6" ← Moist medium discolored SAND & GRAVEL fill						
	2		← Wet fine silty oxidized brown SAND & GRAVEL fill						
	3		3'0" ← Wet silty sandy clayey organic PEAT, with vegetation						
	4		4'0" ← Moist silty organic discolored CLAY, with vegetation						
	5		4'6" ← Moist silty organic CLAY, with oxidation streaks, a trace of vegetation						
	6		5'6"						
	7		7'0" ← Moist silty oxidized slightly organic variegated CLAY, with wet sand lenses						
	8								
	9								
	10								
	11								
	12								
	13								
	14								
	15								
	16								
	17								
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS
G.W. ENCOUNTERED AT FT. INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES

McDOWELL & ASSOCIATES
Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. SW-3

Job No. 89-630 Well No. SW-3 Type 2"

Piezometer No. ______

Type and Size of Auger 4¼" I.D. From 7'0" To surface

Type and Size of Casing ______ From ______ To ______

Wash Boring With ______ Bit From ______ To ______

Size of Screen .010" Type SS

Bottom of Screen Set At 7'0"

Riser Pipe 2" PVC from 2'0" to surface

Filter No. 3 tan sand From 7'0" To 1'9"

Bentonite ¼" pellets From 1'9" To 6"

Grout Cement/bentonite From 6" To surface

Well Protector 4" steel

Developed With ______

Remarks Top of casing elevation 1,012.43

LOG OF SOIL BORING NO. SW-4

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi Mill Facility

JOB NO. 89-630

LOCATION M-59 & Waterbury
Highland Township, Michigan

SURFACE ELEV. ______ DATE 11-14-89 11-15-89

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
			0'1" ASPHALT						
	1		0'7" Moist oxidized medium to coarse SAND, with fine gravel, well graded						
	2		2'6" Moist gray fine clayey SAND fill						
	3		3'6" Clayey sandy fiberous black PEAT						
	4								
	5								
A	6		Stiff to very stiff moist blue silty CLAY, with silt seams & vegetation	4					
				5					
	7			9					
				12					
	8								
B	9			7					
			9'0" Very stiff moist brown clayey SILT, with blue clay seams, non-plastic	12					
	10			17					
			10'0"	17					
	11								
	12								
	13								
	14								
	15								
C	16		P.P. 1 TSF	3					
				3					
	17			3					
			Firm moist blue silty CLAY, plastic	3					
	18								
	19								
	20								
D	21		P.O. 0.5 TSF	2					
				2					
	22			4					
				4					
	23		23'0"						
	24								
	25		Soft moist blue silty CLAY, plastic						

TYPE OF SAMPLE
- D. - DISTURBED
- U.L. - UNDIST. LINER
- S.T. - SHELBY TUBE
- S.S. - SPLIT SPOON
- R.C. - ROCK CORE
- ( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT		2	FT.	0	INS.
G.W. ENCOUNTERED AT			FT.		INS.
G.W. AFTER COMPLETION			FT.		INS.
G.W. AFTER	HRS.		FT.		INS.
G.W. VOLUMES					

LOG OF SOIL BORING NO. SW-4 continued

McDOWELL & ASSOCIATES
Geotechnical Engineers

JOB NO. 89-630

PROJECT Hi Mill Facility

LOCATION M-59 & Waterbury

Highland Township, Michigan

SURFACE ELEV.

DATE 11-14-89
11-15-89

Sample	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
E				2					
	26		Soft moist blue silty CLAY, plastic	2					
				2					
	27		27'0"	4					
	28								
	29								
	30								
	31								
	32								
	33								
	34		4½" Hollow auger, Boring advanced to 7'0" on 11-14-89 terminated due to rain and lightning, boring extended to completion 11-15-89. Hole grouted with Cement Bentonite Slurry by Tremie full depth.						
	35								
	36								
	37								
	38								
	39								
	40								
	41								
	42								
	43								
	44								
	45								
	46								
	47								
	48								
	49								
	50								

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 2 FT. 0 INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES

McDOWELL & ASSOCIATES
Geotechnical Engineers

LOG OF SOIL BORING NO. SW-4A

PROJECT: Hi Mill Facility

JOB NO.: 89-630

LOCATION: M-59 & Waterbury, Highland Township, Michigan

SURFACE ELEV.:

DATE: 11-16-89

Sample & Type	Depth	Legend	Soil Description	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	0'1"		ASPHALT						
	0'7"		Moist oxidized medium to coarse SAND, with fine gravel, well graded						
	2'6"		Moist gray fine clayey SAND fill						
	3'6"		Clayey sandy fiberous black PEAT						
			Stiff to very stiff moist plastic blue silty CLAY, with silt seams and vegetation						
	7'0"								
A			Extremely stiff moist variegated silty CLAY, with fine sand seams and lenses, plastic	7, 9, 18, 20					
B	10'0"		Very stiff to extremely stiff moist silty CLAY, plastic	5, 11, 17, 23					
C				5, 7, 12, 21					
D	13'6"		Stiff to very stiff moist blue silty CLAY, with silt lenses, plastic	6, 8, 11, 13					
E				4, 4, 4, 6					
	17'0"								

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
P. - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140 # Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 0 FT. 0 INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES

McDOWELL & ASSOCIATES
Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. SW-4A

Job No. 89-630 Well No. SW-4A Type 2"

Piezometer No. ______

Type and Size of Auger 4¼" I.D. From 17'0" To surface

Type and Size of Casing ______ From ______ To ______

Wash Boring With ______ Bit From ______ To ______

Size of Screen .010 Type SS

Bottom of Screen Set At 12'6"

Riser Pipe 2" PVC 7'6" to surface

Filter No. 3 tan sand From 12'6" To 6'10"

Bentonite ¼" pellets From 6'10" To 6'0"

Grout Cement/bentonite From 6'0" To Surface

Well Protector 4" steel

Developed With ______

Remarks Top of casing elevation 1,010.18'

LOG OF SOIL BORING NO. SW-5

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi Mill Facility

JOB NO. 89-630

LOCATION M-59 & Waterbury

SURFACE ELEV. ______ DATE 11-21-89 Highland Township, Michigan

Sample & Type	Depth	Legend	Soil Description	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
			0'3" Wet sandy TOPSOIL fill						
	1								
	2		Wet dark brown fine SAND fill, with a trace of coarse sand, organic, well graded						
	3		3'0"						
	4		Compact wet brown medium to coarse SAND, well graded						
	5								
A				4					
	6		6'0"	5					
			Moist blue silty sandy CLAY, with sand & silt seams, plastic	3					
	7		7'0"	4					
	8								
	9								
	10								
	11								
	12								
	13								
	14								
	15								
	16								
	17								
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT	0	FT.	0	INS.
G.W. ENCOUNTERED AT	1	FT.	6	INS.
G.W. AFTER COMPLETION		FT.		INS.
G.W. AFTER ___ HRS.		FT.		INS.

Hollow Auger

McDOWELL & ASSOCIATES
Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. SW-5

Job No. 89-630 Well No. SW-5 Type 2"

Piezometer No. ______

Type and Size of Auger 4¼" I.D. From 0 To 7'0"

Type and Size of Casing ______ From ______ To ______

Wash Boring With ______ Bit From ______ To ______

Size of Screen .010 Type SS

Bottom of Screen Set At 6'11"

Riser Pipe 2" PVC from 1'11"

Filter #3 Tan Sand From 6'11" To 1'6"

Bentonite Pellets From 1'6" To 0'6"

Grout Cement/Bentonite From 0'6" To Surface

Well Protector None

Developed With ______

Remarks Top of Casing Elevation 1,011.95

LOG OF SOIL BORING NO. SB-6

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi-Mill Facility

JOB NO. 201-8058-13

LOCATION M-59 and Waterbury

SURFACE ELEV.

DATE 11/22/89

Highland Township, Michigan

Sample & Type	Depth	Legend	Soil Description		Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
			0"-6"	Sand, pred. fine to medium						
	1			some silt, ocassional fine						
				gravel, sub-angular to sub-						
	2			round, moist to saturated	4					
				brown	5					
	3	A	6"-1'6"	Clay with considerable	4					
				organic content and some						
	4			silt, medium to high plasti-						
				city, moist to saturated,						
	5			mottle dark brown, orange						
				brown and blue grey	9					
	6	B	1'6"-3'3"	Clay with some silt and some	18					
				organic content, medium to	22					
	7			high plasticity, moist,						
				mottle orange brown and						
	8			blue grey						
			3'3"-6'	Clay with some silt,						
	9			occasional fine sand, medium						
				to high plasticity, stiff,						
	10			slightly moist, orange						
				brown and blue grey,						
	11			occasional light grey						
				mottling						
	12									
			NOTE:	Drill rig broke trying to						
	13			withdraw A-rod from 6'6".						
				Borehole grouted and						
	14			abandoned.						
	15		5'0"	EOB						
	16									
	17									
	18									
	19									
	20									
	21									
	22									
	23									
	24									
	25									

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:
Logged by Joel Hunt, Techna

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS
G.W. ENCOUNTERED AT None FT. INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES

LOG OF SOIL BORING NO. SW-6B

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi-Mill Facility

JOB NO. 201-8058-13

LOCATION M-59 and Waterbury
Highland Township, Michigan

SURFACE ELEV. ______ **DATE** 12/14/89

Sample & Type	Depth	Legend	Soil Description		Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
			0"-1'0"	Sand and gravel, well graded to fine gravel, round to sub-round, moist to saturated, brown						
	1									
	2									
	3		1'0"-2'6"	Silty clay with some medium to coarse sand, some roots or wood, dark brown, light brown and grey green layers						
	4									
	5									
	6		2'6"-13'0"	Silty clay, medium to high plasticity, stiff, moist grey and tan laminations, some dark brown spots and reddish stains between laminations						
	7									
	8									
					7					
	9	A			11					
					11					
	10				17					
	11		11'0"	EOB						
					4					
	12	B			4					
					6					
	13				7					
	14									
	15									
	16									
	17									
	18									
	19									
	20									
	21									
	22									
	23									
	24									
	25									

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:
Logged by Rob Erps, Techna

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS
G.W. ENCOUNTERED AT 0 FT. 6 INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES

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Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. SW-6B

Job No. 201-8058-13 Well No. SW-6B Type 2"

Piezometer No. ______

Type and Size of Auger 4¼" From 11'0" To Surface

Type and Size of Casing ______ From ______ To ______

Wash Boring With ______ Bit From ______ To ______

Size of Screen 0.010 Type SS

Bottom of Screen Set At 10'10"

Riser Pipe 2" PVC from 5'10" to surface

Filter No. 3 tan sand From 10'10" To 4'7"

Bentonite Pellets From 4'7" To 2'5"

Grout Cement/beutonite From 2'5" To Surface

Well Protector 4" diameter, 5' long round steel with hinged locking cover

Developed With ______

Remarks Top of casing elevation 1011.63

McDOWELL & ASSOCIATES
Geotechnical Engineers

LOG OF SOIL BORING NO. SW-7

JOB NO. 89-630

PROJECT Hi Mill Facility

LOCATION M-59 & Waterbury

SURFACE ELEV. ______ **DATE** 11-21-89 Highland Township, Michigan

Sample & Type	Depth	Legend	Strata Depth	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	1		1'6"	Wet brown SAND & GRAVEL fill, with stones						
	2									
A					4					
	3			Stiff moist blue silty CLAY fill, with sand and layers of wood	9					
					5					
	4		4'6"		3					
	5									
B				Firm moist variegated silty CLAY fill, with roots and sand layers	2					
	6				2					
					3					
	7				5					
C					6					
	8				8					
			8'6"		11					
	9				13					
	10									
	11			Very stiff moist blue silty CLAY, with silt seams, plastic						
	12									
	13									
D	14				7					
					7	27				
	15		15'0"		6			*	(2000)	
					9					
	16									
	17									
	18									
	19									
	20									
	21									
	22									
	23									
	24									
	25									

TYPE OF SAMPLE
- D. - DISTURBED
- U.L. - UNDIST. LINER
- S.T. - SHELBY TUBE
- S.S. - SPLIT SPOON
- R.C. - ROCK CORE
- P. - PENETROMETER

REMARKS:

* Calibrated Penetrometer

Standard Penetration Test - Driving 2" OD Sampler 1' With 140 # Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 0 FT. 0 INS.
G.W. ENCOUNTERED AT ____ FT. ____ INS.
G.W. AFTER COMPLETION ____ FT. ____ INS.
G.W. AFTER ____ HRS. ____ FT. ____ INS.
G.W. VOLUMES Hollow Auger

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Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. SW-7

Job No. 89-630 Well No. SW-7 Type 2"

Piezometer No. ____

Type and Size of Auger 4¼" I.D. From 0 To 15'0"

Type and Size of Casing ____ From ____ To ____

Wash Boring With ____ Bit From ____ To ____

Size of Screen .010 Type PVC

Bottom of Screen Set At 15'0"

Riser Pipe 2" PVC from 10'0"

Filter #3 Tan Sand From 15'0" To 9'0"

Bentonite Pellets From 9'0" To 7'11"

Grout Cement/Bentonite From 7'11" To Surface

Well Protector 4" Dia steel with locking hinged top

Developed With ____

Remarks Top of Casing Elevation 1,010.36

LOG OF SOIL BORING NO. SW-8

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi-Mill Facility

JOB NO. 201-8058-13

LOCATION M-59 and Waterbury
Highland Township, Michigan

SURFACE ELEV. ______ DATE 12/14/89

Sample & Type	Depth	Legend	Soil Description		Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F	Dry Den Wt P.C.F	Unc. Comp. Strength PSF	Str. %
	1, 2		0"-1'3"	Sand and gravel, poorly graded, round to sub-angular, moist, reddish brown						
	3, 4		1'3"-1'9"	Silty clay with some sand, trace gravel, moist, light brown						
	5, 6	A	1'9"-2'0"	Clayey silt and sand with some fine gravel, moist, dark brown	5 7 9 12					
	7, 8, 9	B ST	2'0"-5'0"	Clayey sand, pred. fine, some fine gravel, moist greenish black						
	10, 11, 12	C	5'0"-10'0"	Silty clay, occasional fine sand seams, trace vegetation, medium plastic, stiff moist, gray and light brown laminae with occasional reddish brown lenses	5 6 10 9					
	13, 14, 15		10'0"-12'0"	Silty clay, with some reddish roots, medium plastic moist to saturated, gray with tan laminae, some reddish streaks						
	16		10'0"	EOB						
	17–25									

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:
Logged by Rob Erps, Techna

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS
G.W. ENCOUNTERED AT 8 FT. 0 INS.
G.W. ENCOUNTERED AT ___ FT. ___ INS.
G.W. AFTER COMPLETION ___ FT. ___ INS.
G.W. AFTER ___ HRS. ___ FT. ___ INS.
G.W. VOLUMES

McDOWELL & ASSOCIATES
Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. SW-8

Job No. 201-8058-13 Well No. SW-8 Type 2"

Piezometer No. ____

Type and Size of Auger 4¼" From 10'0" To Surface

Type and Size of Casing ____ From ____ To ____

Wash Boring With ____ Bit From ____ To ____

Size of Screen 0.010 Type SS

Bottom of Screen Set At 10'3"

Riser Pipe 2" PVC from 5'3" to surface

Filter No. 3 tan sand From 5'3" To 5'0"

Bentonite Pellets From 5'0" To 3'6"

Grout Cement/beutonite From 3'6" To Surface

Well Protector 4" diameter 5' long round steel with hinged locking cover

Developed With Top of casing elevation 1,010.85

Remarks ____

LOG OF SOIL BORING NO. SW-9

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi Mill Manufacturing

JOB NO. 89-630

LOCATION M-59 & Waterbury
Highland Township, Michigan

SURFACE ELEV. ________ **DATE** 1-18-90

Sample & Type	Depth	Legend	Soil Description	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
	0–2'0"		Moist SAND & GRAVEL fill with chunks of clay and some vegetation						
	2'0"–4'0"		Stiff moist olive brown CLAY with vegetation, plastic						
A UL	4'0"–6'0"		Extremely stiff moist variegated CLAY, plastic	9, 16, 20, 20					
B UL	6'0"–9'6"		Extremely stiff moist brown CLAY, plastic	9, 15, 18, 22					
C UL	9'6"–12'6"		Stiff moist blue silty CLAY plastic	5, 7, 8, 11					
D UL	12'6"–21'0"		Firm to stiff wet blue silty CLAY, with wet silt lenses	3, 3, 3, 7					
E UL				3, 4, 4, 6					
F UL				3, 4, 4, 4					

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
P. - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140 # Hammer Falling 30": Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT		12	FT.	6	INS.
G.W. ENCOUNTERED AT			FT.		INS.
G.W. AFTER COMPLETION			FT.		INS.
G.W. AFTER	HRS.		FT.		INS.
G.W. VOLUMES	Dry				

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21355 Hatcher Avenue
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Phone: (313) 399-2066

Boring No. SW-9

Job No. 89-630 Well No. SW-9 Type 2"

Piezometer No. ______

Type and Size of Auger 4¼" I.D. From 21'0" To Surface

Type and Size of Casing ---- From ______ To ______

Wash Boring With ---- Bit From ______ To ______

Size of Screen .010 Type PVC

Bottom of Screen Set At 20'0" - 15'0"

Riser Pipe 15'0" to Surface

Filter No. 3 tan sand From 20'0" To 10'0"

Bentonite ½" pellets From 10'0" To 7'5"

Grout Cement/Bentonite From 7'5" To Surface

Well Protector 4" square steel

Developed With ______

Remarks Top of Casing Elevation 1,010.10

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Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. SW-9

Job No. 201-8058-13 Well No. SW-9 Type 2"

Piezometer No. ______

Type and Size of Auger 4¼" From 20'0" To Surface

Type and Size of Casing ______ From ______ To ______

Wash Boring With ______ Bit From ______ To ______

Size of Screen 0.010 Type PVC

Bottom of Screen Set At 20'0"

Riser Pipe 2" PVC from 15'0"

Filter No. 3 tan sand From 20'0" To 10'0"

Bentonite Pellets From 10'0" To 7'5"

Grout Cement/Bentonite From 7'5" To Surface

Well Protector 4" diameter x 7' long steel with locking hinged top

Developed With ______

Remarks Top of casing elevation 1,010.10

LOG OF SOIL BORING NO. SW-9A

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi-Mill Facility

JOB NO. 201-8058-13

LOCATION M-59 and Waterbury
Highland Township, Michigan

SURFACE ELEV. ______ DATE 3/26/90

Sample & Type	Depth	Legend	SOIL DESCRIPTION		Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
	1		0"-4"	Clayey silt with considerable sand, trace gravel, low plasticity, moist brown topsoil						
	2									
	3		4"-6"	Silty clay, medium plasticity, moist, variegated grey and brown						
	4									
	5		6"-1'9"	Sand with some silt and trace gravel, pred. medium to coarse, saturated brown						
	6									
	7		1'9"-2'1"	Clayey peat, moist to saturated, brown						
	8									
	9		2'1"-3'0"	Silty clay, with trace sand and vegetation, low-medium plasticity, moist, grey brown to variegated grey and brown						
	10									
	11									
	12		7'0"	EOB						
	13		NOTE:	Hand-auger boring						
	14									
	15									
	16									
	17									
	18									
	19									
	20									
	21									
	22									
	23									
	24									
	25									

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:
Logged by Grant DeWitt, Techna

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT		0 FT.	6 INS.
G.W. ENCOUNTERED AT		FT.	INS.
G.W. AFTER COMPLETION		FT.	INS.
G.W. AFTER	HRS.	FT.	INS.
G.W. VOLUMES			

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Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. SW-9A

Job No. 201-8058-13 Well No. SW-9A Type 2"

Piezometer No. ______

Type and Size of Auger 3" hand auger From 7'0" To Surface

Type and Size of Casing ______ From ______ To ______

Wash Boring With ______ Bit From ______ To ______

Size of Screen 0.010 Type PVC

Bottom of Screen Set At 7'0"

Riser Pipe 1'6" to surface

Filter No. 3 tan sand From 7'0" To 1'6"

Bentonite Pellets From 1'6" To 1'4"

Grout Cement From 1'4" To Surface

Well Protector 4" x 4½" long square steel with locking hinged top

Developed With ______

Remarks Top of casing elevation

LOG OF SOIL BORING NO. SW-10

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi Mill Manufacturing

JOB NO. 89-630

LOCATION M-59 & Waterbury
Highland Township, Michigan

SURFACE ELEV. ____ **DATE** 1-18-90

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	1		Moist CLAY fill with organics						
A UL	2		1'6" Wet black clayey TOPSOIL	3, 6					
	3		2'0" Stiff moist blue silty CLAY with trace of vegetation and fine sand seams	7, 10					
B UL	4			4, 6					
	5		4'0" Compact wet medium grained SAND	6, 7					
C UL	6		4'6" Extremely stiff wet brown silty CLAY	6, 14					
	7		7'0"	19, 19					
	8								
	9								
	10								
	11								
	12								
	13								
	14								
	15								
	16								
	17								
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS
G.W. ENCOUNTERED AT ____ FT. ____ INS.
G.W. ENCOUNTERED AT ____ FT. ____ INS.
G.W. AFTER COMPLETION 1 FT. 0 INS.
G.W. AFTER ____ HRS. ____ FT. ____ INS.
G.W. VOLUMES Medium

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Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. SW-10

Job No. 89-630 Well No. SW-10 Type 2"

Piezometer No. ____

Type and Size of Auger 4¼" I.D. From 7'0" To Surface

Type and Size of Casing ---- From ____ To ____

Wash Boring With ---- Bit From ____ To ____

Size of Screen .010 Type SS

Bottom of Screen Set At 4'6" - 1'6"

Riser Pipe 1'6" to Surface

Filter No. 3 tan sand From 7'0" To 1'5"

Bentonite ¼" pellets From 1'5" To 10"

Grout Cement/Bentonite From 10" To Surface

Well Protector 4" round steel

Developed With ____

Remarks Top of Casing Elevation 1,010.50

LOG OF SOIL BORING NO. SW-11

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi Mill Facility

JOB NO. 89-630

LOCATION M-59 & Waterbury

SURFACE ELEV. ______ DATE 11-14-89 Highland Township, Michigan

Sample & Type	Depth	Legend	Soil Description	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
			0'3" Moist brown sandy clayey TOPSOIL						
	1								
	2		Moist brown silty CLAY						
	3		3'0"						
	4								
	5								
A			Stiff moist variegated clayey SILT	4					
	6			5					
				6					
	7			8					
	8								
	9								
	10								
B				2					
	11			3					
			11'6"	5					
	12		Firm to stiff moist blue silty CLAY	6					
	13								
	14								
	15								
C				2					
	16		16'0" Medium compact moist gray sandy SILT	2					
				3					
	17		17'0"	3					
	18		Medium compact moist blue silty CLAY, with sandy silt layers						
	19								
	20								
D				4					
	21			3					
				2					
	22		22'0"	2					
	23								
	24								
	25								

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS
G.W. ENCOUNTERED AT 10 FT. 0 INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES

McDOWELL & ASSOCIATES
Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. SW-11

Job No. 89-630 Well No. SW-11 Type 2"

Piezometer No. ______

Type and Size of Auger 4½" H.A. From Surface To 20'0"

Type and Size of Casing ______ From ______ To ______

Wash Boring With ______ Bit From ______ To ______

Size of Screen .010 Type ss

Bottom of Screen Set At 19'0"

Riser Pipe 0-14'0"

Filter #3 Tan Sand From 20'0" To 13'0"

Bentonite Pellets From 13'0" To 10'6"

Grout Cement/Bentonite From 10'6" To Surface

Well Protector 4" Dia steel with hinged cover

Developed With ______

Remarks Top of Casing Elevation 1,013.04

LOG OF SOIL BORING NO. SW-12

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi-Mill Facility

JOB NO. 201-8058-13

LOCATION M-59 and Waterbury
Highland Township, Michigan

SURFACE ELEV.

DATE 12/12/89

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
	1		0"-6" Silty sand pred. fine, some clay, low-medium plasticity occasional coarse sand, sub-angular to sub-round, moist, dark brown						
	2								
	3								
	4		6"-10'0" Silty clay, medium-high plasticity, slightly moist to moist, tan with grey and occasional greyish white laminae, varved						
	5								
	6			7					
	7	A	NOTE: 1" moist to saturated silt seam at approximately 3'6"	12 10 15					
	8								
	9	B	NOTE: Split-spoon saturated outside slightly moist inside on Sample B.						
	10								
	11		10'0" EOB						
	12								
	13								
	14								
	15								
	16								
	17								
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								

TYPE OF SAMPLE
- D. - DISTURBED
- U.L. - UNDIST. LINER
- S.T. - SHELBY TUBE
- S.S. - SPLIT SPOON
- R.C. - ROCK CORE
- ( ) - PENETROMETER

REMARKS:

Logged by Joel Hunt, Techna

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT		7 FT.	0 INS.
G.W. ENCOUNTERED AT		FT.	INS.
G.W. AFTER COMPLETION		FT.	INS.
G.W. AFTER	HRS.	FT.	INS.
G.W. VOLUMES			

McDOWELL & ASSOCIATES
Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. SW-12

Job No. 201-8058-13 Well No. SW-12 Type 2"

Piezometer No. ____

Type and Size of Auger 4¼" From 10'0" To Surface

Type and Size of Casing ____ From ____ To ____

Wash Boring With ____ Bit From ____ To ____

Size of Screen 0.010 Type PVC

Bottom of Screen Set At 10'0"

Riser Pipe 2" PVC from 4'6" to surface

Filter No. 3 tan sand From 10'0" To 4'4"

Bentonite Pellets From 4'4" To 2'2"

Grout Cement/Bentonite From 2'2" To Surface

Well Protector 4" diameter round steel with locking hinged top

Developed With ____

Remarks Top of casing elevation 1,013.14

LOG OF SOIL BORING NO. SW-13

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi Mill Facility

JOB NO. 89-630

LOCATION M-59 & Waterbury

SURFACE ELEV. ______ DATE 11-10-89 Highland Township, Michigan

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
			0'7" Dark brown moist clayey TOPSOIL						
	1								
	2		Moist variegated silty CLAY, with a trace of sand						
	3		3'0"						
A SS	4		Very stiff moist variegated clayey SILT, with a trace of sand	7					
				10					
	5			12					
			5'6"	15					
	6		Very stiff wet variegated SILT & CLAY (slight seepage @6' in silt seams)						
	7								
	8		8'0"						
B SS	9		Stiff moist variegated silty CLAY, with occasional silt seams	4					
				5					
	10			7					
				10					
	11		11'6"						
	12								
	13		Firm moist blue silty CLAY, with silt seams (seams are wet)						
C SS	14			3					
				3					
	15			4					
				5					
	16								
	17		17'0" **Boring Grouted upon completion.						
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS
G.W. ENCOUNTERED AT 6 FT. 0 INS.
G.W. ENCOUNTERED AT ___ FT. ___ INS.
G.W. AFTER COMPLETION Dry FT. ___ INS.
G.W. AFTER ___ HRS. ___ FT. ___ INS.
G.W. VOLUMES Trace very light

McDOWELL & ASSOCIATES
Geotechnical Engineers

LOG OF SOIL BORING NO. SW-14

PROJECT Hi Mill Manufacturing

JOB NO. 89-630

LOCATION M-59 & Waterbury Highland Township, Michigan

SURFACE ELEV. ______ DATE 12-20-89

Sample & Type	Depth	Legend		SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
			0'6"	Moist silty clayey brown TOPSOIL						
	1									
	2			Moist brown silty CLAY with a trace of vegetation, plastic						
	3		3'0"							
	4									
	5			Very stiff moist variegated silty CLAY, plastic						
A					8					
SS	6				9					
					15					
	7				17					
	8		8'0"							
	9			Stiff moist blue silty CLAY, with oxidation, silt lenses, plastic						
	10									
B					4					
SS	11				5					
					8					
	12		12'0"							
	13			Firm moist blue silty CLAY, with a 3" wet gray silty seams below 14'6"						
C					4					
SS	14				3					
					4					
	15		15'0"		3					
D					2					
SS	16			Soft moist blue silty CLAY	2					
					2					
	17				3					
	18		18'0"							
	19			Firm to stiff moist blue very silty CLAY, plastic						
E					2					
SS	20				4					
					4					
	21				4					
	22									
	23									
F					2					
SS	24				4					
			24'6"		3					
	25									

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140 # Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS
G.W. ENCOUNTERED AT FT. INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES

McDOWELL & ASSOCIATES
Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. SW-14

Job No. 89-630 Well No. SW-14 Type 2"

Piezometer No. ____

Type and Size of Auger 4¼" I.D. From 24'6" To Surface

Type and Size of Casing ---- From ____ To ____

Wash Boring With ---- Bit From ____ To ____

Size of Screen .010 Type PVC

Bottom of Screen Set At 16'0"

Riser Pipe 2" PVC from 11'0" to surface

Filter No. 3 tan sand From 24'6" To 10'0"

Bentonite ¼" Pellets From 10'0" To 8'0"

Grout Cement/Bentonite From 8'0" To Surface

Well Protector 4" Square steel

Developed With ____

Remarks Top of Casing Elevation 1,009.76

LOG OF SOIL BORING NO. SW-15

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi-Mill Facility

JOB NO. 201-8058-13 **LOCATION** M-59 and Waterbury

SURFACE ELEV. **DATE** 12/11/89 Highland Township, Michigan

Sample & Type	Depth	Legend	Soil Description		Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
			0"-9"	Silty sand, pred. fine, some clay, some roots, sub-angular to sub-round, moist, brown, topsoil						
	1									
	2									
	3		9"-2'6"	Clayey sand, pred. fine, considerable silt, some sub-angular to sub-round medium sand, medium plasticity, moist, tan						
	4									
	5				7					
					10					
	6	A	2'6"-14'0"	Clay, some silt, medium plasticity, slightly moist to moist, tan with grey laminae, occasional greyish white laminae	15					
					14					
	7									
	8									
	9		NOTE:	Sample B, no recovery. Split Spoon wet.						
					5					
	10				7					
		B			9					
	11				11					
					5					
	12		12'0"	EOB	6					
					7					
	13	C			8					
	14									
	15									
	16									
	17									
	18									
	19									
	20									
	21									
	22									
	23									
	24									
	25									

TYPE OF SAMPLE
- D. - DISTURBED
- U.L. - UNDIST. LINER
- S.T. - SHELBY TUBE
- S.S. - SPLIT SPOON
- R.C. - ROCK CORE
- ( ) - PENETROMETER

REMARKS:
Logged by Joel Hunt, Techna

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT		3 FT.	9 INS.
G.W. ENCOUNTERED AT		FT.	INS.
G.W. AFTER COMPLETION		FT.	INS.
G.W. AFTER	HRS.	FT.	INS.
G.W. VOLUMES			

McDOWELL & ASSOCIATES
Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. SW-15

Job No. 201-8058-13 Well No. SW-15 Type 2"

Piezometer No. ______

Type and Size of Auger 4¼" From 12'0" To Surface

Type and Size of Casing ______ From ______ To ______

Wash Boring With ______ Bit From ______ To ______

Size of Screen 0.010 Type PVC

Bottom of Screen Set At 11'7"

Riser Pipe 2" PVC from 6'7" to surface

Filter No. 3 tan sand From 11'7" To 5'0"

Bentonite Pellets From 5'0" To 3'0

Grout Cement/Bentonite From 3'0" To Surface

Well Protector 4" round steel with locking hinged top

Developed With ______

Remarks Top of casing elevation 1,010.93

McDOWELL & ASSOCIATES
Geotechnical Engineers

LOG OF SOIL BORING NO. SW-16

JOB NO. 201-8058-13

PROJECT Hi-Mill Facility

LOCATION M-59 and Waterbury
Highland Township, Michigan

SURFACE ELEV.

DATE 12/11/89

Sample & Type	Depth	Legend	Soil Description		Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
			0"-2"	Silty sand, pred. very fine, with some clay and occasional coarse sand, fine gravel and roots, moist to saturated, dark brown, topsoil						
	1									
	2									
	3									
	4		2"-1'5"	Silty sand, pred. very fine, with some clay, saturated tannish brown						
	5				10					
					15					
	6	A	1'5"-14'0"	Silty clay, medium plasticity, slight moist to moist, tan with some grey laminations, occasional black specks and orange staining	17					
					15					
	7									
	8									
	9		NOTE:	Frost depth approximately 2".						
	10				6					
					8					
	11	B			9					
					9					
	12									
	13									
	14				3					
					6					
	15				7					
		C			6					
	16									
	17									
	18									
	19									
	20				2					
					2					
	21	D			4					
					4					
	22									
	23				3					
		E			2					
	24				2					
					3					
	25		25'0"	EOB						
			Boring grouted upon completion.							

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:
Logged by Joel Hunt, Techna

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS
G.W. ENCOUNTERED AT 0 FT. 2 INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES

LOG OF SOIL BORING NO. SW-17

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi Mill Facility

JOB NO. 89-630

LOCATION M-59 & Waterbury

SURFACE ELEV. ______ DATE 11-9-89 Highland Township, Michigan

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
			Moist dark brown sandy						
	1		1'0" silty TOPSOIL						
	2		Moist brown silty fine						
			2'6" SAND, with traces of clay						
	3		and gravel						
			Moist brown clayey SAND						
A	4			4					
SS			4'6"	6					
	5			8					
			Extremely stiff moist	14					
	6		variegated silty CLAY,						
			with a trace of sand and						
	7		occasional silt & fine sand						
			seams						
	8								
B	9			5					
SS				8					
	10			10					
				13					
	11								
	12								
	13		13'0"						
			Stiff to very stiff moist						
C	14		blue silty CLAY,with silt	4					
SS			and fine sand seams	6					
	15			7					
			(NOTE: Wet gray silt seams	7					
	16		between 20'6" & 21'0")						
	17								
	18								
D	19			3					
SS				3					
	20			3					
				4					
	21								
	22		22'0"						
			Stiff moist gray clayey						
	23		SILT, with a trace of fine						
			sand & occasional silt						
E	24		seams	4					
SS				5					
	25			6					
				7					

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT		20	FT.	6	INS.
G.W. ENCOUNTERED AT		32	FT.	0	INS.
G.W. AFTER COMPLETION			FT.		INS.
G.W. AFTER	HRS.		FT.		INS.
G.W. VOLUMES					

LOG OF SOIL BORING NO. SW-17 continued

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi Mill Facility

JOB NO. 89-630

LOCATION M-59 & Waterbury

SURFACE ELEV. ______ DATE 11-9-89 Highland Township, Michigan

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	26								
	27		27'0"						
	28		Stiff moist blue silty CLAY						
	29								
F				4					
SS	30			5					
				7					
	31			13					
			31'6"						
	32								
	33		Compact wet gray silty SAND, with a trace						
	34								
G				3					
SS	35			5					
				8					
	36			10					
	37								
	38								
	39								
H				14					
SS	40			6					
				7					
	41			9					
	42		42'0"						
	43								
	44								
	45								
	46								
	47								
	48								
	49								
	50								

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS
G.W. ENCOUNTERED AT FT. INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES

McDOWELL & ASSOCIATES
Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. SW-17

Job No. 89-630 Well No. SW-17 Type 2"

Piezometer No. ______

Type and Size of Auger 4½" I.D. From 42'0" To surface

Type and Size of Casing ______ From ______ To ______

Wash Boring With ______ Bit From ______ To ______

Size of Screen .010 Type SS

Bottom of Screen Set At 35'0"

Riser Pipe 2" PVC from 30'0" to surface

Filter No. 3 tan sand From 35'0" To 29'0"

Bentonite ½" pellets From 29'0" To 28'0"

Grout Cement/bentonite From 28'0" To surface

Well Protector 4" steel

Developed With ______

Remarks Top of casing elevation 1,012.83'

LOG OF SOIL BORING NO. SW-18

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi Mill Facility

JOB NO. 89-630

LOCATION M-59 & Waterbury

SURFACE ELEV. ——

DATE 11-10-89

Highland Township, Michigan

Sample & Type	Depth	Legend		SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	1		1'0"	Moist dark brown sandy silty TOPSOIL						
	2		2'6"	Moist brown silty SAND, with a trace of clay						
	3									
A SS	4			Stiff moist brown sandy CLAY, with sand seams	2					
					5					
	5			(Note: Wet seam 3" thick @6'6")	5					
					6					
	6			Tip : Clayey SAND						
	7		6'10"	Cobble @ 8'0"						
	8			Cobble @8'0"						
B SS	9				3					
				Medium compact wet brown silty SAND, with traces of gravel & pebbles, clay seams & cobble	2					
	10				3					
					4					
	11									
	12			Water Level @ 10'6" with augers @ 15'						
	13									
C SS	14				5					
					5					
	15				4					
					7					
	16									
	17		17'0"							
	18									
	19									
	20									
	21									
	22									
	23									
	24									
	25									

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
(PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 6 FT. 6 INS. HSD
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES

McDOWELL & ASSOCIATES
Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. SW-18

Job No. 89-630 Well No. SW-18 Type 2"

Piezometer No. ______

Type and Size of Auger 4¼" I.D. From 17'0" To surface

Type and Size of Casing ______ From ______ To ______

Wash Boring With ______ Bit From ______ To ______

Size of Screen .010 Type SS

Bottom of Screen Set At 14'1"

Riser Pipe 2" PVC from 9'1" to surface

Filter No. 3 tan sand From 14'1" To 5'0"

Bentonite ¼" pellets From 5'0" To 4'0"

Grout Cement/bentonite From 4'0" To surface

Well Protector 4" steel

Developed With ______

Remarks Top of casing elevation 1,008.58'

McDOWELL & ASSOCIATES
Geotechnical Engineers

LOG OF SOIL BORING NO. SW-19

PROJECT Hi Mill Facility

JOB NO. 89-630

LOCATION M-59 & Waterbury

SURFACE ELEV. ______ **DATE** 11-8-89 Highland Township, Michigan

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
	1		0'11" Moist dark brown fine sandy clayey silty TOPSOIL						
	2								
	3		3'0" Moist brown silty SAND, with a trace of clay and occasional pebbles, cobbles						
	4								
A				3					
SS	5		Extremely stiff moist variegated SILT & CLAY, with occasional silt and fine sand seams	11					
				15					
	6			18					
	7								
	8								
	9								
B				7					
SS	10			11					
				12					
	11			15					
	12		12'0"						
	13								
	14		Stiff moist blue Stiff moist gray clayey SILT, with occasional silt seams						
C				4					
SS	15			5					
				5					
	16		P.P. = 1.0 TSF	7					
	17								
	18								
	19								
D				4					
SS	20			8					
				11					
	21		21'0"	11					
	22								
	23		Compact to very compact wet brown silty fine SAND, with a trace of gravel and occasional oxidized silt seams						
E	24			2					
SS				4					
	25			7					
				5					

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT	12	FT.	0	INS.	
G.W. ENCOUNTERED AT	11	FT.	0	INS.	
G.W. AFTER COMPLETION	13	FT.	1	INS.	
G.W. AFTER		HRS.		FT.	INS.
G.W. VOLUMES					

LOG OF SOIL BORING NO. [illegible] continued

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi Mill Facility

JOB NO. 89-630

LOCATION M-59 & Waterburg

SURFACE ELEV. ______ DATE 11-8-89

Highland Township, Michigan

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp Strength PSF	Str. %
	26								
	27								
	28								
	29								
FS			Compact to very compact wet brown silty fine SAND, with a trace of gravel and occasional oxidized silt seams	2					
SS	30			5					
				5					
	31			13					
	32								
	33								
	34								
G				4					
SS	35			5					
				9					
	36			13					
	37		37'0"						
	38								
	39								
	40								
	41								
	42								
	43								
	44								
	45								
	46								
	47								
	48								
	49								
	50								

TYPE OF SAMPLE
- D. - DISTURBED
- U.L. - UNDIST. LINER
- S.T. - SHELBY TUBE
- S.S. - SPLIT SPOON
- R.C. - ROCK CORE
- ( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140 # Hammer Falling 30". Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT FT. INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES

McDOWELL & ASSOCIATES
Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. SW-19

Job No. 89-630 Well No. SW-19 Type 2"

Piezometer No. ______

Type and Size of Auger 4½" I.D. From 37'0" To surface

Type and Size of Casing ______ From ______ To ______

Wash Boring With ______ Bit From ______ To ______

Size of Screen .010" Type SS

Bottom of Screen Set At 32'0"

Riser Pipe 2" PVC from 27'0" to surface

Filter No. 3 tan sand From 32'0" To 26'0"

Bentonite ½" pellets From 26'0" To 25'0"

Grout Cement/bentonite From 25'0" To surface

Well Protector 4" steel

Developed With ______

Remarks Top of casing elevation 1,015.61'

LOG OF SOIL BORING NO. SW-20

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi Mill Facility

JOB NO. 89-630

LOCATION M-59 & Waterbury

SURFACE ELEV.

DATE 11-13-89

Highland Township, Michigan

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
			0'5" Dark brown sandy TOPSOIL						
	1								
			Wet silty brown SAND						
	2								
			2'6"						
	3								
	4		Extremely stiff moist variegated silty CLAY						
	5								
A				5					
	6			14					
				18					
	7			23					
	8								
	9								
	10								
B			10'6"	8					
	11		Stiff moist blue silty CLAY, with some silt seams	6					
				7					
	12		12'0"	10					
	13								
	14								
	15								
	16								
	17								
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								

TYPE OF SAMPLE

D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 0 FT. 7 INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES Hollow Auger

McDOWELL & ASSOCIATES
Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. SW-20

Job No. 89-630 Well No. SW-20 Type 2"

Piezometer No. ______

Type and Size of Auger 4¼" I.D. From 12'0" To surface

Type and Size of Casing ______ From ______ To ______

Wash Boring With ______ Bit From ______ To ______

Size of Screen .010 Type ss

Bottom of Screen Set At 6'0"

Riser Pipe 1'0" below to 2'0" above grade 2" PVC

Filter #3 Tan Sand From 6'6" To Surface

Bentonite ______ From ______ To ______

Grout ______ From ______ To ______

Well Protector 2" Cast Aluminum lock cover provided by M & A

Developed With ______

Remarks Top of Casing Elevation 1,009.76

SW-21

LOG OF SOIL BORING NO.

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi Mill Facility

JOB NO. 89-630

LOCATION M-59 & Waterbury
Highland Township, Michigan

SURFACE ELEV. ______ DATE 11-17-89

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
			0'2" ASPHALT						
	1		Wet fine silty oxidized brown SAND & GRAVEL fill, with slight clay content						
	2								
	3		3'0"						
	4		Moist silty organic discolored CLAY, with vegetation						
	5		5'0"						
A				5					
D	6		Stiff to very stiff moist silty organic CLAY, with oxidation streaks, a trace of vegetation, roots and wet sand lenses	8					
				9					
	7		7'0"	13					
	8								
	9								
	10								
	11								
	12								
	13								
	14								
	15								
	16								
	17								
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS
G.W. ENCOUNTERED AT 0 FT. 2 INS.
G.W. ENCOUNTERED AT 6 FT. 0 INS.
G.W. AFTER COMPLETION 2 FT. 0 INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES Heavy Hollow Auger

McDOWELL & ASSOCIATES
Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. SW-21

Job No. 89-630 Well No. SW-21 Type 2"

Piezometer No. ______

Type and Size of Auger 4½" I.D. From 7'0" To surface

Type and Size of Casing ______ From ______ To ______

Wash Boring With ______ Bit From ______ To ______

Size of Screen .010" Type PVC

Bottom of Screen Set At 7'0"

Riser Pipe 2" PVC from 2'0" to surface

Filter No. 3 tan sand From 7'0" To 1'10"

Bentonite ½" pellets From 1'10" To 6"

Grout Cement/bentonite From 6" To Surface

Well Protector 4" steel

Developed With ______

Remarks ______

LOG OF SOIL BORING NO. SW-22

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi Mill Manufacturing

JOB NO. 89-630

LOCATION M-59 & Waterbury

Highland Township, Michigan

SURFACE ELEV. ______ DATE 1-18-90

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	1								
A UL	2		Miscellaneous SAND & CLAY fill	3					
				4					
				4					
	3		3'0"	6					
B UL	4		Very stiff moist variegated CLAY, plastic	5					
				10					
				13					
	5			28					
			5'6"						
	6								
	7								
	8								
	9								
	10								
	11								
	12								
	13								
	14								
	15								
	16								
	17								
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30": Count Made At 6" Intervals

GROUND WATER OBSERVATIONS
G.W. ENCOUNTERED AT ___ FT. ___ INS.
G.W. ENCOUNTERED AT ___ FT. ___ INS.
G.W. AFTER COMPLETION ___ FT. ___ INS.
G.W. AFTER ___ HRS. ___ FT. ___ INS.
G.W. VOLUMES None

McDOWELL & ASSOCIATES
Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. SW-22

Job No. 89-630 Well No. SW-22 Type 2"

Piezometer No. ______

Type and Size of Auger 4¼" I.D. From 5'6" To Surface

Type and Size of Casing ---- From ______ To ______

Wash Boring With ---- Bit From ______ To ______

Size of Screen 1010 Type SS

Bottom of Screen Set At 5'0" to Surface

Riser Pipe 2'0" to Surface

Filter No. 3 tan sand From 5'6" To 2'0"

Bentonite ¼" pellets From 2'0" To 1'6"

Grout Cement/Bentonite From 1'6" To Surface

Well Protector 4" round steel

Developed With ______

Remarks Top of Casing Elevation 1,010.25

LOG OF SOIL BORING NO. IW-1

McDOWELL & ASSOCIATES
Geotechnical Engineers

JOB NO. 89-630

PROJECT Hi-Mill Manufacturing

LOCATION M-59 & Waterbury
Highland Township, Michigan

SURFACE ELEV.

DATE 1-9-90

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
	26								
	27								
	28								
	29		AUGERED TO 35' NO SAMPLE						
	30								
	31								
	32								
	33								
	34								
	35		35'0"						
A				3					
	36		Firm moist blue silty CLAY, plastic	3					
				4					
	37			5					
	38								
	39								
	40								
B				5					
	41		41'0" Very stiff moist blue silty CLAY	9					
				16					
	42		41'9"	20					
			Very compact wet medium to coarse brown SAND						
	43								
	44		44'0"						
	45								
C			Compact wet medium to coarse brown SAND, with seams of gray clayey sand	6					
	46			7					
				9					
	47			11					
	48								
D				6					
	49		49'0" Very compact wet brown fine SAND	9					
				12					
	50		50'0"	13					

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 22 FT. 0 INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES

McDOWELL & ASSOCIATES
Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. IW-1

Job No. 89-630 Well No. IW-1 Type SS

Piezometer No. ______

Type and Size of Auger 4¼" I.D. From 50'0" To Surface

Type and Size of Casing ---- From ______ To ______

Wash Boring With ---- Bit From ______ To ______

Size of Screen .010 Type SS

Bottom of Screen Set At 47'0" to 42'0"

Riser Pipe 42'0" to Surface

Filter No. 3 tan From 50'0" To 39'10"

Bentonite ¼" pellets From 39'10" To 36'6"

Grout Cement/Bentonite From 36'6" To Surface

Well Protector 4" square steel

Developed With ______

Remarks Top of Casing Elevation 1,017.02

McDOWELL & ASSOCIATES
Geotechnical Engineers

LOG OF SOIL BORING NO. IW-2

PROJECT: Hi Mill Facility

JOB NO. 89-630

LOCATION: M-59 & Waterbury, Highland Township, Michigan

SURFACE ELEV. ______

DATE: 12-12-89

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
	1		Moist brown fine silty SAND with clay content, fill						
	2								
A		2'6"							
UL	3		Wet brown sandy SILT with clay						
	4								
	5								
B		5'6"							
UL	6		Moist tan CLAY with gray streaks and silt lenses						
	7								
	8								
	9								
	10								
C				5					
UL	11			6					
		11'5"		10					
	12		Stiff moist blue CLAY with silt varves	15					
	13								
	14								
	15								
D				2					
UL	16			4					
				4					
	17			6					
	18								
E		18'6"	Firm to stiff moist blue CLAY with silt and sand lenses	3					
UL	19			5					
				6					
	20			9					
	21								
	22								
	23								
	24								
F				25					
UL	25			3					
				3					

TYPE OF SAMPLE

- D. - DISTURBED
- U.L. - UNDIST. LINER
- S.T. - SHELBY TUBE
- S.S. - SPLIT SPOON
- R.C. - ROCK CORE
- ( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT ___ FT. ___ INS.
G.W. ENCOUNTERED AT ___ FT. ___ INS.
G.W. AFTER COMPLETION ___ FT. ___ INS.
G.W. AFTER ___ HRS. ___ FT. ___ INS.
G.W. VOLUMES

LOG OF SOIL BORING NO. IN-2 (continued)

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi Mill Facility

JOB NO. 89-630

LOCATION M-59 & Waterbury
Highland Township, Michigan

SURFACE ELEV.

DATE 12-12-89

Sample & Type	Depth	Soil Description	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
	25–28	Firm to stiff moist blue CLAY with silt and sand lenses	15					
		28'0"						
G UL	30–32		3, 3, 4, 5					
	28–38	Firm moist blue CLAY with varved lenses of silt						
#1 ST	35–37							
		38'0"						
	38–42	Medium compact wet gray medium to coarse SAND						
H UL	40–42		3, 5, 2, 8					
		42'0"						
	43–50	Logged by Robert Erp, Techna Corporation						

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140 # Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS
G.W. ENCOUNTERED AT FT. INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES

McDOWELL & ASSOCIATES
Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. IW-2

Job No. 89-630 Well No. IW-2 Type 2"

Piezometer No. ______

Type and Size of Auger 4¼" I.D. From 46'6" To Surface

Type and Size of Casing 10" PVC Sch. 80 From 17'0" To Surface

Wash Boring With ---- Bit From ______ To ______

Size of Screen .010" Type SS

Bottom of Screen Set At 46'6"

Riser Pipe 2" PVC 41'6" to surface

Filter Natural sand From 46'6" To 39'4"

Bentonite 35 gal. bentonite slurry From 39'4" To 38'±

Grout Cement/bentonite From 38'± To Surface

Well Protector 4" Square steel

Developed With ______

Remarks Top of Casing Elevation 1,014.56

LOG OF SOIL BORING NO. IW-3

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi Mill Facility

JOB NO. 89-630

LOCATION M-59 & Waterbury
Highland Township, Michigan

SURFACE ELEV. ____ DATE 11-29-89

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
	1–11		Hole drilled through 11'4" of 10" Dia PVC Casing.						
			11'4"						
A	12–20		Stiff moist blue silty CLAY with tan silt lenses and plastic	4, 4, 4, 4					
			20'0"						
B	21–25		Stiff moist blue silty CLAY with seams of wet gray fine sand, plastic	2, 5, 7, 5					
			25'0"						

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
P. - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 15 FT. 0 INS.
G.W. ENCOUNTERED AT 30 FT. 0 INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES Hollow Auger

LOG OF SOIL BORING NO. IW-3 continued

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi Mill Facility

JOB NO. 89-630

LOCATION M-59 & Waterbury

SURFACE ELEV. ______ DATE 11-29-89 Highland Township, Michigan

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
C	26		Stiff moist blue silty CLAY, with wet gray silt lenses	3					
				3					
	28			5					
				4					
	30								
D				2					
	32			4					
				5					
	34			6					
E	36			3					
				3					
	38			5					
				6					
	40		40'0" **Sampler sank under own weight from 40' to 42'						
	42								
F				3					
	44			4					
				7					
	46			9					
	48		Well graded wet medium to coarse gray SAND, with a trace of fine gravel						
	50								
	52								
	54								
	56								
	58								
	60		60'0"						
	62								
	64								
	66								
	68								
	70								
	72								
	74								
	76								

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140 # Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 15 FT. 0 INS.
G.W. ENCOUNTERED AT 30 FT. 0 INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS FT. INS.
G.W. VOLUMES

McDOWELL & ASSOCIATES
Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. IW-3

Job No. 89-630   Well No. IW-3   Type 2" SS/PVC

Piezometer No. ______

Type and Size of Auger 4¼" I.D.   From 60'0"   To Surface

Type and Size of Casing 10" PVC   From 11'4"   To Surface

Wash Boring With —— Bit   From ______   To ______

Size of Screen .010   Type 2" SS

Bottom of Screen Set At 47'6"

Riser Pipe 2" I.D. PVC from 42'0" to Surface

Filter Natural Sand & #3 Tan Sand   From 47'6"   To 39'7"

Bentonite ¼" Pellets   From 39'7"   To 35'0"

Grout Cement/Bentonite   From 35'0"   To Surface

Well Protector 4" I.D. Steel with hinged top

Developed With ______

Remarks Top of Casing Elevation 1,011.90

LOG OF SOIL BORING NO. IW-4

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi Mill Facility

JOB NO. 89-630

LOCATION M-59 & Waterbury
Highland Township, Michigan

SURFACE ELEV. ______ DATE 11-15-89

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
			Drilled to 8' with 12" Dia Continous Flight Auger, set 10" Dia PVC threaded casing to to 13' depth by pushing. Clea Cleaned out inside of casing with 4.25" dia hollow auger during advancement of casing. 3" standing water in casing after installation. Placed 1/3 bucket of Pelletized Bentonite to absorb standing water.						

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT FT. INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.

LOG OF SOIL BORING NO. IW-4A

McDOWELL & ASSOCIATES
Geotechnical Engineers

JOB NO. 89-630

PROJECT Hi Mill Facility

LOCATION M-59 & Waterbury
Highland Township, Michigan

SURFACE ELEV.

DATE 11-28-89

Sample & Type	Depth	Legend	Soil Description	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	1								
	2								
	3		0'0" to 14" Cement Bentonite Grout inside 10" I.D. PVC Casing.						
	4								
	5								
	6								
	7								
	8								
	9								
	10								
	11								
	12								
	13								
	14		14'0"						
	15								
A ST	16		Firm moist blue silty CLAY, plastic P.P. 0.75 - 1 TSF SHELBY TUBE pushed from 15'0" to 17'6"	PUSH	28		*	(3500)	
	17								
	18								
	19								
	20								
	21								
	22		**See log of IW-4 for Soil Descriptions between 17'6" and 30'0"						
	23								
	24								
	25								

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:
* Calibrated Penetrometer

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT		47	FT.	6	INS.
G.W. ENCOUNTERED AT		50	FT.	0	INS.
G.W. AFTER COMPLETION			FT.		INS.
G.W. AFTER	HRS.		FT.		INS.
G.W. VOLUMES	Hollow Auger				

McDOWELL & ASSOCIATES
Geotechnical Engineers

LOG OF SOIL BORING NO. IW-4A continued

PROJECT: Hi Mill Facility

JOB NO. 89-630

LOCATION: M-59 & Waterbury, Highland Township, Michigan

SURFACE ELEV. ______

DATE 11-28-89

Sample & Type	Depth	Legend	Soil Description	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	26								
	27								
	28								
	29								
	30		30'0"						
B				3					
	31			3					
			Firm moist blue silty CLAY, plastic	4					
	32			8					
	33								
	34								
	35								
C				1					
	36			2					
				3					
	37			3					
	38								
	39								
	40		40'0"						
D				2					
	41		Stiff moist blue silty CLAY, plastic	4	31			2185	
				5	31	120	*	(1500)	
	42			5			*	(2185)	
E				3					
	43			3					
				6					
	44			7					
F				3					
	45			5					
				7					
	46			7					
G				3					
	47			4	22				
			47'6" Compact wet fine gray silty SAND, well graded	4			*	(1500)	
	48		48'0"	12					
	49		Attempt to push Shelby Tube below 48' unsuccessfull, drove Split Spoon instead,						
	50		50'0"						

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:
Continued
* Calibrated Penetrometer

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS
G.W. ENCOUNTERED AT 47 FT. 8 INS.
G.W. ENCOUNTERED AT 50 FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES Hollow Auger

LOG OF SOIL BORING NO. IW-4A continued

McDOWELL & ASSOCIATES
Geotechnical Engineers

JOB NO. 89-630

PROJECT Hi Mill Facility

LOCATION M-59 & Waterbury

Highland Township, Michigan

SURFACE ELEV. —

DATE 11-28-89

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	51		Sampler advanced from 48' to 50' with weight of hammer only						
H				5					
	52			5					
				7					
	53			13					
	54		Very compact wet gray medium grained SAND, unifrom size, angular						
	55								
	56								
	57								
	58								
	59								
	60		60'0"						
	61								
	62								
	63								
	64								
	65								
	66								
	67								
	68								
	69								
	70								
	71								
	72								
	73								
	74								
	75								

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 47 FT. 6 INS.
G.W. ENCOUNTERED AT 50 FT. 0 INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS FT INS.

McDOWELL & ASSOCIATES
Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. IW-4A

Job No. 89-630 Well No. IW-4A Type 2" SS/PVC

Piezometer No. ______

Type and Size of Auger 4¼" I.D. From 0 To 60'

Type and Size of Casing 10" PVC From 13'0" To Surface

Wash Boring With —— Bit From ______ To ______

Size of Screen .010 Type SS

Bottom of Screen Set At 54'0"

Riser Pipe 49'0" to Surface PVC

Filter Sand cave in From 54'0" To 46'6"

Bentonite ¼" Pellets From 46'6" To 45'0"

Grout Cement/Bentonite From 45'0" To Surface

Well Protector 4" I.D. Steel with hinged top

Developed With ______

Remarks SS drive point for screen provided by McDowell & Associates.

Top of casing elevation 1,010.06

LOG OF SOIL BORING NO. IW-5

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi-Mill Manufacturing

JOB NO. 89-630

LOCATION M-59 & Waterbury
Highland Township, Michigan

SURFACE ELEV. ______ DATE 1-10-90

Sample & Type	Depth	Legend		Soil Description	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
	20									
	21									
	22									
	23									
	24									
	25		25'0"							
A				Stiff moist blue silty CLAY, plastic	P					
ST	26				U					
					S					
	27				H					
B	28				3					
SS			28'6"	Compact wet gray medium to coarse SAND, with a trace of fine gravel	5					
	29		29'3"		7					
					8					
	30			Compact wet gray fine to medium SAND						
	31									
	32									
	33		33'0"							
	34									
	35			Extremely compact wet gray medium to coarse SAND, with a trace of fine gravel						
C					9					
SS	36				22					
					17					
	37				10					
	38									
	39									
	40									
D					10					
SS	41				14					
					18					
	42		42'0"		18					
	43									
	44									

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With

GROUND WATER OBSERVATIONS
G.W. ENCOUNTERED AT FT. INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.

McDOWELL & ASSOCIATES
Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. IW-5

Job No. 89-630 Well No. IW-5 Type 2"

Piezometer No. ______

Type and Size of Auger 4½" I.D. From 42'0" To Surface

Type and Size of Casing 10" I.D. From 20'0" To Surface

Wash Boring With ______ Bit From ______ To ______

Size of Screen .010" Type SS

Bottom of Screen Set At 35'0"

Riser Pipe PVC from 30'0" to Surface

Filter #3 Tan Sand From 35'0" To 26'6"

Bentonite ½" Pellets From 26'6" To 25'3"

Grout Cement/ Bentonite From 25'3" To Surface

Well Protector 4" Square Steel

Developed With ______

Remarks Top of casing elevation 1,009.39

LOG OF SOIL BORING NO. DW-1

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi Mill Facility

JOB NO. 89-630

LOCATION M-59 & Waterbury
Highland Township, Michigan

SURFACE ELEV. ______ **DATE** 12-18-89

Sample Type	Depth	Legend		Soil Description	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	26									
	28									
	30									
	32									
				Water in augers to 20' at start of drilling (Boring drilled to 40' 12-15-89)						
	34									
	36									
	38									
	40		40'0"							
				Compact wet gray medium grained SAND, with some fine gravel						
	42									
	44									
I	46				9					
UL					5					
	48		48'0"		5					
					5					
	50			Extremely compact wet gray medium grained SAND						
J					26					
UL	52				27					
			53'0"		29					
	54									
				Slightly compact wet gray medium SAND, with trace of fine gravel						
K	56				3					
UL					1					
	58				1					
			59'0"		1					
	60				1					
L					1					
UL	62			Compact wet gray medium SAND	5					
					5					
	64				6					
			65'6"		10					
M	66			Extremely stiff moist blue silty CLAY	13					
UL			66'6"		13					
	68		68'0"	Moist gray SILT	20					
					22					
	70			Extremely compact wet gray medium SAND	10					
N			71'0"		11					
UL	72				21					
				Extremely compact wet gray fine silty SAND	31					
	74		74'0"		11					
				Extremely compact wet gray fine grained SAND	23					
O	76				54					

TYPE OF SAMPLE
D - DISTURBED
U.L. - UNDIST. LINER
S.T - SHELBY TUBE
S.S - SPLIT SPOON
R.C. - ROCK CORE
( ) - PEN[illegible]METER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT		20	FT.	0	INS.
G.W. ENCOUNTERED AT			FT.		INS.
G.W. AFTER COMPLETION			FT.		INS.
G.W. AFTER	HRS.		FT.		INS.
G.W. VOLUMES					

LOG OF SOIL BORING NO. DW-1 continued

McDOWELL & ASSOCIATES
Geotechnical Engineers

JOB NO. 89-630

PROJECT Hi Mill Facility

LOCATION M-59 & Waterbury

Highland Township, Michigan

SURFACE ELEV. ____ DATE 12-18-90

Sample Type	Depth	Legend	Soil Description	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str %
UL	77								
	79		Extremely compact wet gray fine grained SAND						
P	81			15					
UL				33					
	83			63					
			84'0"						
	85		Extremely compact wet gray fine sandy SILT						
Q				17					
UL	87			21					
				32					
	89		88'6"						
			Extremely compact wet gray SILT						
R	91			17					
UL			92'0"	22					
	93			29					
	95								
	97								
	99								
	101								
	103								
	105								
	107								
	109								
	111								
	113								
	115								
	117								
	119								
	121								
	123								
	125								
	127								

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS
G.W. ENCOUNTERED AT 20 FT. 0 INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS. FT. INS.
G.W. VOLUMES

McDOWELL & ASSOCIATES
Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. DW-1

Job No. 89-630 Well No. Dw-1 Type 2"

Piezometer No. ____

Type and Size of Auger 4¼" I.D. From 92'0" To Surface

Type and Size of Casing 10" I.D. Sch. 80 PVC From 15'0" To Surface

Wash Boring With ---- Bit From ____ To ____

Size of Screen .010" Type SS

Bottom of Screen Set At 83'0"

Riser Pipe 2" PVC from

Filter Natural sand From 92'0" To 41'6"

Bentonite 30 gal. bentonite slurry From 41'6" To 39'6"±

Grout Cement/bentonite From 39'6"± To Surface

Well Protector 4" square steel

Developed With ____

Remarks Top of Casing Elevation 1,014.62

LOG OF SOIL BORING NO. DW-2

McDOWELL & ASSOCIATES
Geotechnical Engineers

JOB NO. 89-630

PROJECT Hi Mill Facility

LOCATION M-59 & Waterbury

Highland Township, Michigan

SURFACE ELEV.

DATE 11-30-89

Sample Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
	26		See log of IW-3 for Soil Description above 35'. Top 13' of Boring made inside 10" I.D. PVC Casing.						
	27								
	28								
	29								
	30								
	31								
	32								
	33								
	34								
	35		35'0" Pushed Shelby Tube from 35' to 37'6", piece of wood present in bottom of tube						
A				P					
ST	36			U					
				S					
	37		Stiff moist blue silty CLAY, with silt lenses, plastic	H					
				--					
B	38			4					
SS				7					
	39			8					
				9					
	40								
	41								
	42								
	43		43'0"						
	44		Wet gray coarse SAND, with stones & lenses of blue clay, well graded						
	45								
C	46								
	47								
	48								
	49		49'0"						
	50								

TYPE OF SAMPLE
- D. - DISTURBED
- U.L. - UNDIST. LINER
- S.T. - SHELBY TUBE
- S.S. - SPLIT SPOON
- R.C. - ROCK CORE
- ( ) - PENETROMETER

REMARKS: Water inside casing at start of drilling.

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT		7	FT.	0	INS.
G.W. ENCOUNTERED AT			FT.		INS.
G.W. AFTER COMPLETION			FT.		INS.
G.W. AFTER	HRS.		FT.		INS.
G.W. VOLUMES	Hollow Auger				

LOG OF SOIL BORING NO. DW-2 continued

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi Mill Facility

JOB NO. 89-630

LOCATION M-59 & Waterbury

SURFACE ELEV. ____ DATE 11-30-89 Highland, Michigan

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
D				3					
	51		Compact wet gray medium to coarse SAND, well graded	4					
				6					
	52			14					
	53								
	54								
	55								
	56								
E				5					
	57	57'0"		5	12				
			Compact wet gray fine to medium grained SAND, with soft blue clay in bottom of sample	3					
	58		**Hard drilling indicates possible presence of stiff clay between these depths.	1					
	59								
	60	6'0"							
F				8					
	61		Slightly compact wet gray fine to medium grained SAND, with stiff moist blue clay seams	2					
				1					
	62	62'0"		1					
	63		Extremely stiff moist blue silty CLAY HARDPAN, with sandy clay in tip of sampler						
	64								
	65								
G				12					
	66			30	15				
				47					
	67			80					
	68	68'0"							
	69		Extremely stiff moist blue silty sandy CLAY HARDPAN						
	70								
H				34					
	71			46					
				60					
	72								
	73								
	74								
	75								

TYPE OF SAMPLE
- D. - DISTURBED
- U.L. - UNDIST. LINER
- S.T. - SHELBY TUBE
- S.S. - SPLIT SPOON
- R.C. - ROCK CORE
- ( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30". Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT 7 FT. 0 INS.
G.W. ENCOUNTERED AT FT INS.
G.W. AFTER COMPLETION FT INS.
G.W. AFTER HRS FT INS.
G.W. VOLUMES

LOG OF SOIL BORING NO. DW-2 Continued

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi Mill Facility

JOB NO. 89-630

LOCATION M-59 & Waterbury

SURFACE ELEV.

DATE 11-31-89

Highland Township, Michigan

Sample & Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str. %
	76								
I				28					
	77		77'0"	42					
				65					
	78		Extremely stiff moist blue silty sandy CLAY HARDPAN, with fine gravel						
	79								
	80								
	81								
J				58					
	82		82'0"	108					
			Extremely compact wet gray fine to medium grained SAND, well graded	--					
	83								
	84								
	85								
	86								
K				13					
	87		87'0"	28	15				
			Boulders encountered below 87'0"	52					
	88								
	89								
	90		90'0"						
	91								
	92		End of Boring 90'0" Screen 86'6" Sand to 77'4 Bentonite 30 gallons Grout						
	93								
	94								
	95								
	96								
	97								
	98								
	100								
	101								

TYPE OF SAMPLE
- D. - DISTURBED
- U.L. - UNDIST. LINER
- S.T. - SHELBY TUBE
- S.S. - SPLIT SPOON
- R.C. - ROCK CORE
- ( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS
- G.W. ENCOUNTERED AT 7 FT. 0 INS.
- G.W. ENCOUNTERED AT FT. INS.
- G.W. AFTER COMPLETION FT. INS.
- G.W. AFTER HRS FT. INS.
- G.W. VOLUMES Hollow Auger

McDOWELL & ASSOCIATES
Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. DW-2

Job No. 89-630 Well No. DW-2 Type SS/PVC

Piezometer No. ____

Type and Size of Auger 4¼" I.D. From Surface To 90'0"

Type and Size of Casing 10" I.D. PVC From Surface To 13'0"

Wash Boring With ____ Bit From ____ To ____

Size of Screen .010 Type SS

Bottom of Screen Set At 86'6"

Riser Pipe 81'6" to Surface

Filter #3 Tan Sand From 81'6" To 77'4"

Bentonite 40 Gal Bentonite Slurry From 77'4" To ?

Grout Cement/Benotnite From Top of Bentonite To Surface

Well Protector 4" I.D. Steel with hinged top

Developed With ____

Remarks Top of Casing Elevation 1,011.99

MA

McDOWELL & ASSOCIATES
Geotechnical Engineers

LOG OF SOIL BORING NO. DW-5

PROJECT Hi-Mill Manufacturing

JOB NO. 89-630

LOCATION M-59 & Waterbury

SURFACE ELEV. ____ DATE 1-10-90

Highland Township, Michigan

Hole Type	Depth	Legend	SOIL DESCRIPTION	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF.	Str %
	26		Top 20' of Boring inside 10" Dia schedule 80 PVC casing. See IW-5 for soils description to 42'						
	27								
	28								
	29								
	30								
	31								
	32								
	33								
	34								
	35								
	36								
	37								
	38								
	39								
	40								
	41								
	42		42'0"						
	43								
	44								
	45								
A SS	46		Compact to extremely compact wet gray fine silty SAND	4 5 8 11					
	47								
	48								
	49								
	50								

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT ____ FT. ____ INS.
G.W. ENCOUNTERED AT ____ FT. ____ INS.
G.W. AFTER COMPLETION ____ FT. ____ INS.
G.W. AFTER ____ HRS. ____ FT. ____ INS.
G.W. VOLUMES

LOG OF SOIL BORING NO. DW-3 continued

McDOWELL & ASSOCIATES
Geotechnical Engineers

PROJECT Hi-Mill Manufacturing

JOB NO. 89-630

LOCATION M-59 & Waterbury
Highland Township, Michigan

SURFACE ELEV.

DATE 1-10-90

Sample & Type	Depth	Legend	Soil Description	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
B				8					
SS	51		51'0"	15					
				20					
	52		Extremely stiff wet blue silty CLAY, with seams and lenses of gray silt	22					
	53								
	54								
	55								
	56								
C				19					
SS	57			20					
				32					
	58								
	59								
	60								
D				31					
SS	61			31					
				47					
	62								
	63		63'0"						
	64								
	65		Extremely compact moist gray clayey SAND, with seams of fine blue clay and a trace of fine gravel						
	66								
E				8					
SS	67			13					
				19					
	68		68'0"						
	69								
	70		Extremely stiff moist blue silty sandy CLAY, with seams & layers of gray clayey sand						
F				19					
SS	71			30					
				44					
	72								
	73								
	74								
	75								

TYPE OF SAMPLE
D. - DISTURBED
U.L. - UNDIST. LINER
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
R.C. - ROCK CORE
( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30". Count Made At 6" Intervals

GROUND WATER OBSERVATIONS
G.W. ENCOUNTERED AT FT. INS.
G.W. ENCOUNTERED AT FT INS.
G.W. AFTER COMPLETION FT INS.
G.W. AFTER HRS FT INS.
G.W. VOLUMES

LOG OF SOIL BORING NO. DW-3 continued

McDOWELL & ASSOCIATES
Geotechnical Engineers

JOB NO. 89-630

PROJECT Hi-Mill Manufacturing

LOCATION M-59 & Waterbury
Highland Township, Michigan

SURFACE ELEV.

DATE 1-11-90

Sample & Type	Depth	Legend	Soil Description	Penetration Blows For 6"	Moisture %	Natural Wt. P.C.F.	Dry Den Wt. P.C.F.	Unc. Comp. Strength PSF	Str. %
G				25					
SS	76			38					
				42					
	77								
			77'6"						
	78								
	79								
	80		Extremely stiff moist blue silty CLAY, with lenses of gray silt						
H				30					
SS	81			45					
				59					
	82								
	83		83'0"						
	84								
	85		Extremely stiff moist blue sandy CLAY HARDPAN, with a trace of fine gravel						
I				67					
SS	86			86					
				77/5"					
	87								
	88								
	89								
	90								
J				70					
SS	91		90'10"	190/4"					
	92								
	93								
	94								
	95								
	96								
	97								
	98								
	99								
	100								

TYPE OF SAMPLE
- D - DISTURBED
- U.L. - UNDIST. LINER
- S.T. - SHELBY TUBE
- S.S. - SPLIT SPOON
- R.C. ROCK CORE
- ( ) - PENETROMETER

REMARKS:

Standard Penetration Test - Driving 2" OD Sampler 1' With 140 # Hammer Falling 30". Count Made At 6" Intervals

GROUND WATER OBSERVATIONS

G.W. ENCOUNTERED AT FT. INS.
G.W. ENCOUNTERED AT FT. INS.
G.W. AFTER COMPLETION FT. INS.
G.W. AFTER HRS FT. INS.
G.W. VOLUMES

McDOWELL & ASSOCIATES
Geotechnical Engineers
21355 Hatcher Avenue
Ferndale, Michigan 48220
Phone: (313) 399-2066

Boring No. DW-3

Job No. 89-630 Well No. DW-3 Type 2"

Piezometer No. ________

Type and Size of Auger 4½" ID From 90'10" To Surface

Type and Size of Casing 10" ID From 20' To Surface

Wash Boring With ________ Bit From ________ To ________

Size of Screen .010" Type SS

Bottom of Screen Set At 70'0"

Riser Pipe PVC from 65'0" to surface

Filter No.3 Tan Sans From 69'4" To 63'0"

Bentonite ½" Pellets From 63'0" To 61'4"

Grout Cement/Bentonite From 61'4" To Surface

Well Protector 4" Square Steel

Developed With ________

Remarks Top of Casing Elevation 1,009.41

TECHNA CORPORATION

LOG OF SOIL BORING: A1

PROJECT: Hi Mill Manufacturing Co. RI/FS

JOB NO.: 201-8058-13

LOCATION: 1704 Highland Road
Highland, Michigan

SURFACE ELEVATION: 1009.44 DATE: 01-24-90

SAMPLE AND TYPE	DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
			Frost	
	1		8" Sandy clay with fine gravel, moist, brown, plastic	
	2		2'6" Clayey sand, trace gravel and silt, oxidized brown, moist to saturated	
	3		3'11" Silty clay, variegated brown with chalky white lenses, with layers of silt, moist, dilatent	
	4			
	5			
	6		6'0" EOB	
	7		(Soil Clay Interfaced 3'11")	
	8			
	9			
	10			
	11			
	12			
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	16			
	17			
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	22			
	23			
	24			
	25			

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: 5'0"
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: A2

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road
Highland, Michigan

JOB NO.: 201-8058-13

URFACE ELEVATION: 1010.99 DATE: 01-24-90

SAMPLE AND TYPE	DEPTH	LEGEND		SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
				Frost	
A	1		6"	Sandy clay with fine gravel, moist, brown, plastic	
			1'6"	Brown sandy topsoil, moist, vegetation fill	
	2		2'0"	Sandy clay, moist, plastic, trace fine gravel	
B	3				
			3'6"	Clayey silt, low plasticity, dilatent, moist to saturated, brown with vegetation	
	4				
C	5		5'0"	Silty clay, plastic, moist, trace sand, brown with irregular chalky white streaks	
	6		5'6"	Clayey silt, low plasticity, brown, moist to saturated	
			6'6"	Silty clay, moderate plastic, oxidized brown with seams of of brown saturated silt	
D	7				
	8		EOB		
			8'0"	Soil Clay Interace at 6'6"	
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
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	18				
	19				
	20				
	21				
	22				
	23				
	24				
	25				

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT:
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: A3

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road, Highland, Michigan

JOB NO.: 201-8058-13

SURFACE ELEVATION: 1010.58 **DATE:** 01-24-90

SAMPLE AND TYPE		DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
				Clayey topsoil, some sand, moist, brown with vegetation	
A		1			
				6" Silty clay, moist, moderately plastic, variegated with irregular chalky white lenses and fine silty sand	
		2			
B		3		3'0" Silty clay, plastic, moist, thin lamina with seams of brown wet silt	
		4		Soil Clay Interface at 3'0"	
C		5		EOB 5'6"	
		6			
		7			
		8			
		9			
		10			
		11			
		12			
		13			
		14			
		15			
		16			
		17			
		18			
		19			
		20			
		21			
		22			
		23			
		24			
		25			

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: None
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: B1

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road
Highland, Michigan

JOB NO.: 201-8058-13

SURFACE ELEVATION: 1009.38 DATE: 01-24-90

SAMPLE AND TYPE		DEPTH	LEGEND		SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
					3" frost, sandy topsoil, moist with vegetation	
A		1		6"	Sandy clay, plastic, moist, trace fine sand, oxidized brown	
		2		2'0"	Clayey sand, predominately medium, trace fine gravel, saturated with 1" discolored streak at 3'2"	
B		3		3'4"	Silty clay, plastic, moist, thin lamina, with seams of brown wet silt	
		4				
C		5		EOB 5'6"	Soil Clay Interface at 3'4"	
		6				
		7				
		8				
		9				
		10				
		11				
		12				
		13				
		14				
		15				
		16				
		17				
		18				
		19				
		20				
		21				
		22				
		23				
		24				
		25				

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: Surface
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: B2

PROJECT: Hi Mill Manufacturing Co. RI/FS

JOB NO.: 201-8058-13

LOCATION: 1704 Highland Road
Highland, Michigan

SURFACE ELEVATION: 1010.58 DATE: 01-24-90

SAMPLE AND TYPE		DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
A		1		3" 3" frost, sandy clay, moist, trace fine gravel oxidized brown to brown	
		2			
		3		3'8" Silty clay, low plasticity, moist to saturated, seams of wet silt, brown with irregular white streaks	
B		4		EOB 4'0" Soil Clay Interface at 3'8"	
		5			
		6			
		7			
		8			
		9			
		10			
		11			
		12			
		13			
		14			
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		17			
		18			
		19			
		20			
		21			
		22			
		23			
		24			
		25			

TYPE OF SAMPLE	REMARKS	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE S.S. - SPLIT SPOON	REMARKS: Logged by G. DeWitt Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT: 3'6" G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: B[illegible]

PROJECT: Hi Mill Manufacturing Co. RI/FS

JOB NO.: 201-8058-13

LOCATION: 1704 Highland Road
Highland, Michigan

RFACE ELEVATION: 1011.89 **DATE:** 01-24-90

SAMPLE AND TYPE		DEPTH	LEGEND	SOIL DESCRIPTION		PENETRATION BLOWS FOR 6"
					Brown, sandy clayey topsoil with trace vegetation	
A		1		8"	Sandy clay with fine gravel, fill, oxidized brown, plastic	
		2		1'6"	Sandy topsoil fill, moist	
B		3		2'6"	Silty clay fill with sand, plastic, variegated - tan	
		4		4'0"	Silty sand seam	
				4'2"	Silty clay, variegated brown with chalky white lenses and layers of silt, moist dilatent	
C		5				
		6		EOB 6'0"	Soil Clay Interface at 4'2"	
		7				
		8				
		9				
		10				
		11				
		12				
		13				
		14				
		15				
		16				
		17				
		18				
		19				
		20				
		21				
		22				
		23				
		24				
		25				

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: None
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: C1

PROJECT: Hi Mill Manufacturing Co. RI/FS

JOB NO.: 201-8058-13

LOCATION: 1704 Highland Road
Highland, Michigan

SURFACE ELEVATION: 1009.51 **DATE:** 01-24-90

SAMPLE AND TYPE	DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
A			~~Sandy clay, oxidized brown to brown,~~ moist	
	1		8" Silty clay, moist, variegated tan with trace sand	
	2		1'6" Silty clay, moist, variegated brown wit chalky white lenses and layers of silt, dilatent	
B	3			
C	4		Soil Clay Interface at 1'6"	
	5			
D	6		EOB 6'0"	
	7			
	8			
	9			
	10			
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	23			
	24			
	25			

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: None
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: C2

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road
Highland, Michigan

JOB NO.: 201-8058-13

SURFACE ELEVATION: 1010.55 DATE: 01-26-90

SAMPLE AND TYPE	DEPTH	LEGEND		SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
				Medium stiff, moist, plastic to very plastic, oxidized silty brown clay fill with trace sand and gravel and with some vegetation	
	1				
A	2				
B	3		3'0"	Medium stiff moist, variegated oxidized brown silty clay with interlacing veins of chalky white interval and trace gravel	
	4		EOB 4'0"		
	5			Soil Clay Interface at 3'0"	
	6				
	7				
	8				
	9				
	10				
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	15				
	16				
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	18				
	19				
	20				
	21				
	22				
	23				
	24				
	25				

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: None
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: C3

PROJECT: Hi Mill Manufacturing Co. RI/FS

JOB NO.: 201-8058-13

LOCATION: 1704 Highland Road
Highland, Michigan

SURFACE ELEVATION: 1011.17 DATE: 01-26-90

SAMPLE AND TYPE		DEPTH	LEGEND	SOIL DESCRIPTION		PENETRATION BLOWS FOR 6"
A		1			Soil, moist, oxidized brown silty clay fill with trace sand and gravel	
		2		1'0"	Brown clayey topsoil, moist with trace sand and gravel and vegetation	
B		3		2'6"	Medium stiff, moist, oxidized silty brown clay with trace gravel and pebbles, plastic 2" layer of oxidized brown clayey silt, very moist at 3'4"	
C		4		3'6"	Medium stiff, variegated oxidized brown and brown and and chalky white, silty clay very plastic	
D		5				
		6		EOB 6'0"	Soil Clay Interface at 3'6"	
		7				
		8				
		9				
		10				
		11				
		12				
		13				
		14				
		15				
		16				
		17				
		18				
		19				
		20				
		21				
		22				
		23				
		24				
		25				

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: 3'0"
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: D2

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road
Highland, Michigan

JOB NO.:

SURFACE ELEVATION: DATE: 01-26-90

SAMPLE AND TYPE		DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
A		1		6" ~~Fill soft, very soft, moist, oxidized brown~~ silty clay with trace sand and gravel and vegetation, plastic	
		2		2'0" Dark brown clayey topsoil sith trace sand and vegetation	
B		3		3'9" Medium stiff, moist valigated with oxidized brown, grey and dark brown silty clay fill with little sand and trace S.H. gravel - lens of silt at 3'6"	
		4			
		5			
C		6		EOB 6'0" V. stiff, moist, varizgated - oxidized brown and grey silty clay interfaced with chalky white material, trace sand and gravel, plastic	
		7			
		8			
		9		Soil Clay Interface at 3'9"	
		10			
		11			
		12			
		13			
		14			
		15			
		16			
		17			
		18			
		19			
		20			
		21			
		22			
		23			
		24			
		25			

TYPE OF SAMPLE	REMARKS	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	REMARKS: Logged by G. DeWitt	G.W. ENCOUNTERED AT: 3'6"
S.S. - SPLIT SPOON	Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: E2

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road
Highland, Michigan

JOB NO.:

SURFACE ELEVATION: --

DATE: 01-26-90

SAMPLE AND TYPE	DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
A	1		~~Silty clay with sand and vegetation~~ Fill with concrete and asphalt	
	2			
B	3		3'0" Medium stiff, moist, variegated oxidized brown and grey silty clay interfaced with white chalky material, plastic (tope 3" has apparent reddish veneer on clay clumps)	
	4			
C	5			
	6		EOB Soil Clay Interface at 3'0"	
	7–25			

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: 3'6"
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: B3

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road, Highland, Michigan

JOB NO.:

SURFACE ELEVATION: 1010.18 DATE: 01-26-90

SAMPLE AND TYPE		DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
A		1		Stiff, moist, oxidized brown silty fill clay with trace sand and gravel, plastic with vegetation	
		2		2'0" V. stiff, moist, variegated oxidized brown grey silty clay interlaced with white chalky material, v. plastic with trace sand	
B		3			
		4		EOB 4'0" Soil Clay Interface at 3'0"	
		5			
		6			
		7			
		8			
		9			
		10			
		11			
		12			
		13			
		14			
		15			
		16			
		17			
		18			
		19			
		20			
		21			
		22			
		23			
		24			
		25			

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: None
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: F3

PROJECT: Hi Mill Manufacturing Co. RI/FS

JOB NO.: 201-8058-13

LOCATION: 1704 Highland Road
Highland, Michigan

SURFACE ELEVATION: ______ DATE: 01-26-90

SAMPLE AND TYPE		DEPTH	LEGEND		SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
A				6"	Medium stiff moist oxidized brown silty clay fill with trace sand and gravel and vegetation	
		1			Brown clayey topsoil fill with trace sand, plastic and vegetation	
		2		2'0"	Stiff moist variegated oxidized brown and grey silty clay fill with trace sand and dark brown streaks	
B						
		3		3'6"	Very stiff, moist variegated brown and grey silty clay with interlaced white chalky material, very plastic	
C						
		4				
					Soil Clay Interface at 3'6"	
		5				
		6				
		7				
		8				
		9				
		10				
		11				
		12				
		13				
		14				
		15				
		16				
		17				
		18				
		19				
		20				
		21				
		22				
		23				
		24				
		25				

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: None
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: F-4

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road
Highland, Michigan

JOB NO.:

SURFACE ELEVATION: **DATE:** 02-01-90

SAMPLE AND TYPE		DEPTH	LEGEND	SOIL DESCRIPTION		PENETRATION BLOWS FOR 6"
				6"	Brown oxidized silty medium fine, v. moist sand, trace gravel - loose v. moist dark brown clayey topsoil with vegetation, soft slightly plastic, trace oxidation and sand	
		1				
		2		1'8"	Medium stiff plastic variegated oxidized brown and grey silty clay, moist, trace vegetation and sand fill	
		3				
		4		4'0"	V. stiff, moist, v. plastic variegated oxidized brown and grey silty clay with trace of white chalky material interlaced and tan ? of greyish silt and trace vegetation	
		5				
		6			Soil Clay Interface at 4'0"	
		7		EOB 7'6"		
		8				
		9				
		10				
		11				
		12				
		13				
		14				
		15				
		16				
		17				
		18				
		19				
		20				
		21				
		22				
		23				
		24				
		25				

TYPE OF SAMPLE	REMARKS	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE S.S. - SPLIT SPOON	Logged by G. DeWitt Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT: None G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: G3

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road
Highland, Michigan

JOB NO.:

SURFACE ELEVATION: 1008.98 DATE: 01-26-90

SAMPLE AND TYPE		DEPTH	LEGEND	SOIL DESCRIPTION		PENETRATION BLOWS FOR 6"
A				6"	Brown clayey topsoil with little sand trace gravel flost	
		1				
		2				
B				3'0"	Stiff moist variegated oxidized brown and grey silty clay fill trace sand and gravel, trace dark brown silty clay, plastic	
		3				
		4				
C						
		5		5'6"	Medium stiff, moist, organic greenish blue gray silty clay fill, trace sand and gravel	
		6				
D						
		7		EOB 7'6"	V. stiff, moist variegated oxidized brown and grey silty clay, with interstitial chalky white material, some stratification at bottom 6"	
		8				
		9			Soil Clay Interface at 5'6"	
		10				
		11				
		12				
		13				
		14				
		15				
		16				
		17				
		18				
		19				
		20				
		21				
		22				
		23				
		24				
		25				

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: None
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: G1

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road
Highland, Michigan

JOB NO.:

SURFACE ELEVATION: DATE: 02-05-90

SAMPLE AND TYPE	DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
			V. Moist, strong brown topsoil fill, trace gravel	
	1		8" Fine gravel with trace sand fill, loose	
	2		2.'2" Greyish brown medium dense very moist to saturated fine silty sand fill with trace gravel	
	3			
	4			
	5			
	6			
	7			
	8			
	9			
	10			
	11		11' Stiff moist plastic gray silty clay varved with thin lamina of tan and opey silt	
	12		Soil Clay Interface 11'10"	
	13			
	14			
	15			
	16		EOB 16'0"	
	17			
	18			
	19			
	20			
	21			
	22			
	23			
	24			
	25			

TYPE OF SAMPLE	REMARKS	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	REMARKS: Logged by G. DeWitt	None
S.S. - SPLIT SPOON	Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:
		G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: G5

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road
Highland, Michigan

JOB NO.:

SURFACE ELEVATION: ___ DATE: 01-23-90

SAMPLE AND TYPE	DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
A	1		1'0" Clayey sand, predominantly medium, tan with trace fine gravel, moist, well graded	
	2			
B	3		2'6" Clayey sand with some clayey peat, moderate plasticity, organic brown black	
			3'0" Silty clay, slightly moist, plastic, variegated grey and oxidized brown with irregular white grey lenses	
	4			
C	5		Soil Clay Interface at 3'0"	
	6		EOB 6'0"	
	7			
	8			
	9			
	10			
	11			
	12			
	13			
	14			
	15			
	16			
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	24			
	25			

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: None
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: G6

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road

Highland, Michigan

JOB NO.:

SURFACE ELEVATION: **DATE:** 01-22-90

SAMPLE AND TYPE	DEPTH	LEGEND		SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
A	1			Clayey sand, predominately medium, well graded, moist with wood trace fine gravel	
	2				
B	3		3'6"	Silty clay, plastic, moist, variegated - dark grey and oxidized brown with white streaks	
	4				
C	5				
	6		6'0"	Silty clay, brown, moderate plasticity, with thin silt streaks and irregular white-grey lenses and discolored zones	
D	7				
	8		EOB 8'0"	Soil Clay Interface at 3'5"	
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				
	21				
	22				
	23				
	24				
	25				

TYPE OF SAMPLE	REMARKS:	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE S.S. - SPLIT SPOON	Logged by G. DeWitt Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT: None G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: G3/H4

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road
Highland, Michigan

JOB NO.: 201-8058-13

URFACE ELEVATION: 1009.88 DATE: 01-23-90

SAMPLE AND TYPE	DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
A	1		Clayey sand, tan, predominately medium, some fine gravel, moist to saturated, well graded	
	2		2'0"	
B	3			
	4		Same	
C	5			
	6		Same	
D	7			
	8		Same	
E	9		Same	
	10			
F	11		Same	
	12		11'6" Silty clay with lenses of oxidized silt, plastic, moist, varved brown	
G	13		Same	
	14			
H	15		15'6" EOB	
	16		Soil Clay Interface at 11'6"	
	17			
	18			
	19			
	20			
	21			
	22			
	23			
	24			
	25			

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT:
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: H4

PROJECT: Hi Mill Manufacturing Co. RI/FS

JOB NO.: 201-8058-13

LOCATION: 1704 Highland Road
Highland, Michigan

RFACE ELEVATION: ______ DATE: 03-05-90

SAMPLE AND TYPE		DEPTH	LEGEND		SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
				~~3"~~	~~Frost~~	
		1			Brown very sand topsoil with trace vegetation and gravel	
		2				
		3				
		4				
		5		5'0"	Loose wet to saturated brown medium silty sand with trace gravel	
		6				
		7		7'6"	Moist slightly plastic, medium stiff, variegated oxidized brown and grey silty clay with interlacing of white chalky material with occasional thin lamina of grey silt	
		8			EOB	
		9				
		10				
		11				
		12				
		13				
		14				
		15				
		16				
		17				
		18				
		19				
		20				
		21				
		22				
		23				
		24				
		25				

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: ______
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT: ______

TECHNA CORPORATION

LOG OF SOIL BORING: [illegible]

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road
Highland, Michigan

JOB NO.: 201-8058-13

SURFACE ELEVATION: 1007.34 DATE: 02-01-90

SAMPLE AND TYPE		DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
				Brown topsoil with vegetation	
		1		2" Medium stiff, moist, variegated silty clay fill, oxidized brown and greyish blue silty clay	
		2		1'10" Fill with trace fine to medium fine sand	
		3		3'0" Medium stiff moist variegated silty clay fill, oxidized brown and organic blue, slightly plastic to plastic with some peat and clayey peat	
		4		4'6" Stiff moist plastic variegated oxidized brown and grey silty clay with trace vegetation and white clayey material interlaced and trace grey silt	
		5			
		6			
		7		Soil Clay Interface at 3'0"	
		8			
		9			
		10			
		11			
		12			
		13			
		14			
		15			
		16			
		17			
		18			
		19			
		20			
		21			
		22			
		23			
		24			
		25			

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: none
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: H7

PROJECT: Hi Mill Manufacturing Co. RI/FS

JOB NO.:

LOCATION: 1704 Highland Road
Highland, Michigan

SURFACE ELEVATION: 1006.11 **DATE:** 01-19-90

SAMPLE AND TYPE	DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
			5" Black Topsoil	
	1			
A	2			
B	3		2'6" Silty clay, moist, plastic, grey, varved with trace vegetation	
	4			
C	5			
	6		5'11" Sandy, clayey peat, moist, black silty clay, grey, plastic, moist, varved with oxidized streaks, trace vegetation, fine gravel and two seams (1") of medium sand	
D	7			
	8		Soil Clay Interface at 5'11"	
E	9			
	10		EOB 10'	
	11			
	12			
	13			
	14			
	15			
	16			
	17			
	18			
	19			
	20			
	21			
	22			
	23			
	24			
	25			

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT:
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: H3W13

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road
Highland, Michigan

JOB NO.: 201-8058-13

RFACE ELEVATION: ___ DATE: 03-05-90

SAMPLE AND TYPE		DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
				~~Wet brown very loose medium sand fill with little coarse~~ sand and trace silt and vegetation	
		1			
		2		Same wet to saturated	
		3		Same saturated	
		4		Same saturated	
		5		Same saturated	
		6			
		7		7'3" Moist very stiff to hold variegated oxidized brown, brown and grey silty clay with interlacing of white chalky material	
		8			
		9		9'0" EOB	
		10		Soil Clay Interface at 7'3"	
		11			
		12			
		13			
		14			
		15			
		16			
		17			
		18			
		19			
		20			
		21			
		22			
		23			
		24			
		25			

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: Surface
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: H.W14

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road
Highland, Michigan

JOB NO.: 201-8058-13

SURFACE ELEVATION: [illegible] DATE:

SAMPLE AND TYPE		DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
				~~Very loose saturated brown multi colors~~ medium sand fill with trace gravel and little silt and trace vegetation with veneer of sandy clay at surface	
		1			
		2			
		3			
		4		4'6" Loose very moist brown fine clayey sand fill with trace gravel	
		5		5'6" Very loose, saturated, brown multi-colored medium sand fill with trace gravel and little silt and trace vegetation with veneer of sandy clay	
		6			
		7		7'6" Soft, slightly plastic, very moist, grayish brown silty clay fill, trace sand and gravel, some with 4" layer black organic peat at bottom of drive	
		8			
		9			
		10			
		11			
		12		12'4" Same with 3" layer of moist, slightly plastic, variegated, oxidized blue and oxidized brown clay with trace silt and peat at 11'0" Medium stiff, moist, plastic, grey silty clay varved lamina with thin lamina of oxidized brown, tan and greyish silt	
		13			
		14			
		15			
		16			
		17		17'6" Stiff wet plastic grey silty clay with very thin beds of greyish silty clay slightly plastic clayey silt and varved lamina of moist greyish silt	
		18			
		19			
		20			
		21			
		22			
		23			
		24			
		25			

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: 12'0"
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: ~~H4/15~~ 5
PROJECT: Hi Mill Manufac~~turing Co. RI~~/FS
LOCATION: ~~1704 Highland Road~~
~~Highland, Michigan~~

JOB NO.:
SURFACE ELEVATION: DATE: 02-05-90

SAMPLE AND TYPE	DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
	1		~~Moist clayey topsoil, brown, trace sand and~~ and vegetation with a very thin BOD of oxidized brown silty clay, moist	
	2			
	3		3'8" Asphalt	
	4		4'0" Medium stiff, moist, very plastic, variegated oxidized brown and grey silty clay with trace vegetation, thin ? of greyish silt, slight shatification	
	5			
	6			
	7			
	8			
	9			
	10		EOB 10'6" Same with thin lamina of grey sand and tan silt 1silt layers	
	11			
	12			
	13			
	14			
	15			
	16			
	17			
	18			
	19			
	20			
	21			
	22			
	23			
	24			
	25			

TYPE OF SAMPLE	REMARKS	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE S.S. - SPLIT SPOON	REMARKS: Logged by G. DeWitt Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT: ______ G.W. ENCOUNTERED AT: ______

TECHNA CORPORATION

LOG OF SOIL BORING: 13

PROJECT: Hi Mill Manufacturing Co. RI/FS

JOB NO.: 201-8058-13

LOCATION: 1704 Highland Road
Highland, Michigan

SURFACE ELEVATION: — DATE: 02-05-90

SAMPLE AND TYPE	DEPTH	LEGEND		SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
			6"	Moist, dark brown clayey topsoil with trace sand and gravel and vegetation	
	1				
	2			Moist to saturated (wetness increases with depth), medium multi-colored brown sand fill with trace gravel and silt	
	3				
	4				
	5				
	6				
	7		7'0"	Loose, brown, very moist, fine clayey sand trace gravel and vegetation	
	8		8'6"	Soft, very moist, slightly plastic sandy clay fill with some silt greyish brown soft to very soft	
	9				
	10				
	11				
	12				
	13		13'2"	Stiff moist plastic brownish grey silty clay with thin lamina of tan and grey silt	
	14				
	15				
	16				
	17		17'6"	Stiff, moist, plastic, grey silty clay varved thin lamina to lamina of grey clayey silt	
	18			Soil Clay Interface at 13'2"	
	19				
	20				
	21				
	22				
	23				
	24				
	25				

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: 6"
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT: –

TECHNA CORPORATION

LOG OF SOIL BORING: 14

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road
Highland, Michigan

JOB NO.: 201-8058-13

SURFACE ELEVATION: ______ DATE: 02-05-90

SAMPLE AND TYPE	DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
			Moist dark brown clayey sand topsoil fill with trace gravel and vegetation	
	1		1'6" Moist medium dense multi-colored brown medium sand fill with trace silt and gravel	
	2			
	3			
	4			
	5		5'8" Moist brown sandy clay fill with trace gravel and vegetation	
	6			
	7			
	8			
	9		9'8" Stiff moist plastic grey silty clay varved thin lamina to lamina of tan and oxidized silt	
	10			
	11			
	12			
	13			
	14			
	15		15'0" EOB	
	16		Soil Clay Interface at 9'8"	
	17			
	18			
	19			
	20			
	21			
	22			
	23			
	24			
	25			

TYPE OF SAMPLE	REMARKS	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Logged by G. DeWitt Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT: 13'0"
S.S. - SPLIT SPOON		G.W. ENCOUNTERED AT: ____

TECHNA CORPORATION

LOG OF SOIL BORING: 13

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road
Highland, Michigan

JOB NO.:

SURFACE ELEVATION: 1007.42 **DATE:** 01-23-90

SAMPLE AND TYPE	DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
A			~~Clayey sand, predominately mediu, tan, t.~~ fine gravel moist, well-graded	
	1		1'3" Silty clay, slightly moist, valizgated brown with oxidized lenses, plastic	
	2			
	3			
B			3'6" Clayey peat, MDDT, plastic with some vegetation, organic black with 2" layer of peat at 5'10"	
	4			
	5			
C				
	6		6'0" Silty clay, plastic, moist with seams of silty/ fine sand, oxidized brown, thin ? present	
D				
	7			
	8		8'0" Same with streaks of saturated clayey sand, medium with T fine gravel	
E				
	9		Soil Clay Interface at 6'0"	
	10		EOB 10'	
	11			
	12			
	13			
	14			
	15			
	16			
	17			
	18			
	19			
	20			
	21			
	22			
	23			
	24			
	25			

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT:
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT: 5'6"

TECHNA CORPORATION

LOG OF SOIL BORING: 10

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road, Highland, Michigan

JOB NO.:

SURFACE ELEVATION: 1006.82 **DATE:** 01-22-90

SAMPLE AND TYPE		DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
A				0" ~~Moist dark brown peat with wood and vegetation~~	
		1		13" Same - clayey peat	
		2		28" Organic clay with trace fine gravel and sand, plastic	
B		3		35" Clayey sand, medium, moist, trace fine gravel with sandy clay seam 4'6" to 5'2"	
		4			
C		5			
		6		6' Silty clay, moist, thin white and grey lamina	
D		7			
		8		8'-10 Same - With varved silt seams	
E		9			
		10		10'0" EOB	
		11			
		12		Soil Clay Interface at 6'0"	
		13			
		14			
		15			
		16			
		17			
		18			
		19			
		20			
		21			
		22			
		23			
		24			
		25			

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: 3'6"
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: J5

PROJECT: Hi Mill Manufacturing Co. RI/FS

JOB NO.: 201-8058-13

LOCATION: 1704 Highland Road
Highland, Michigan

RFACE ELEVATION: 1006.62 DATE: 01-22-90

SAMPLE AND TYPE	DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
			2" ~~Brown sandy topsoil~~	
	1		Silty clay, moist, mottled grey & brown with trace fine gravel vegetation	
A	2		5" Moist, clayey peat, trace vegetation	
B			11" Grey fine sand moist	
	3		2'0" Very clayey sand, predominately medium with trace fine gravel, moist	
	4		4'0" Silty oxidized grey clay, moist, plastic with seams of predominately fine sand, white ,ateroa;s present	
C	5		Same color of clay is more brown	
	6			
D	7			
	8		8'0" EOB	
	9			
	10		Soil Clay Interface at 4'0"	
	11			
	12			
	13			
	14			
	15			
	16			
	17			
	18			
	19			
	20			
	21			
	22			
	23			
	24			
	25			

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: 6'0"
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: K5

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road
Highland, Michigan

JOB NO.: 201-8058-13

SURFACE ELEVATION: ___ DATE: 02-01-90

SAMPLE AND TYPE	DEPTH	LEGEND	SOIL DESCRIPTION		PENETRATION BLOWS FOR 6"
			4"	~~Dark brown clayey topsoil with little sand, trace gravel~~	
	1		6"	Oxidized brown, moist, silty medium sand, trace gravel coarse bed gravel fill	
	2		2'0"	Slab of concrete	
	3		2'8"	Clayey dark brown organic peat moist, plastic, medium stiff, silty clay fill variegated oxidized brown and blue grey with trace vegetation	
	4				
	5		5'0"	Stiff, moist, plastic variegated silty clay oxidized brown and grey with interlacing of white chalky material and vegetation and occasional lamina of greyish silt	
	6				
	7				
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				
	21				
	22				
	23				
	24				
	25				

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: 2'0"
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: K4

PROJECT: Hi Mill Manufacturing Co. RI/FS

JOB NO.: 201-8058-13

LOCATION: 1704 Highland Road
Highland, Michigan

SURFACE ELEVATION: 1007.97 DATE: 02-01-90

SAMPLE AND TYPE	DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
			Loose medium clayey sand with little gravel, moist oxidized brown, trace vegetation	
	1			
	2		2'0" Dark brown moist clayey peat	
			2'6" Moist slightly plastic, medium stiff silty clay fill, variagated oxidized brown and organic blue grey with trace vegetation and sand	
	3		3'6" Brown and grey with trace vegetation with Interlacing of white clayey material	
	4		4'0" Stiff, moist, plastic to very plastic, aariegated silty clay oxidized	
			4'0" EOB	
	5			
	6			
	7		Soil Clay Interfac at 5'0"	
	8			
	9			
	10			
	11			
	12			
	13			
	14			
	15			
	16			
	17			
	18			
	19			
	20			
	21			
	22			
	23			
	24			
	25			

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: none
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: RS01

PROJECT: Hi Mill Manufacturing Co. RI/FS

JOB NO.: 201-8058-13

LOCATION: 1704 Highland Road
Highland, Michigan

SURFACE ELEVATION: - DATE: 01-29-90

SAMPLE AND TYPE	DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
			3" Asphalt	
A	1		1'3" Sandy gravel fill with trace asphalt, dark grey, white, tan and red gravel	
	2		1'5" Brown, stiff, moist, plastic silty clay interlaced with white chalky material	
B	3		1'7" Greyish tan silt, moist with trace silt	
	4		4'0" Very stiff, moist, plastic to very plastic silty clay, oxidized brown with interlaced white chalky material, trace gravel with tan silt lamina/very thin silt beds	
C	5			
	6		6'0" Same as above with some stratification EOB	
	7		Soil Clay Interface at 1'7"	
	8			
	9			
	10			
	11			
	12			
	13			
	14			
	15			
	16			
	17			
	18			
	19			
	20			
	21			
	22			
	23			
	24			
	25			

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: 9"
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: RS12

PROJECT: Hi Mill Manufacturing Co. RI/FS

NO.: 201-8058-13

LOCATION: 1704 Highland Road
Highland, Michigan

SURFACE ELEVATION: DATE: 01-29-90

SAMPLE AND TYPE	DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
A	1		~~Sandy gravel fill with trace asphalt dark grey, white, tan~~ and red gravel	
	2		1'6" Moist stiff plastic silty clay oxidized brown with white chalky material interlaced and with laminate thin lamina of tan silt stratification increases with depth	
B	3			
	4		4'0" EOB	
	5		Soil Clay Interface at 1'6"	
	6		Repeat Drives A' and A" necessary to obtain sufficient sample volume for chemical analyses	
	7			
	8			
	9			
	10			
	11			
	12			
	13			
	14			
	15			
	16			
	17			
	18			
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	23			
	24			
	25			

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: 0'9"
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: RS23

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road
Highland, Michigan

NO.: 201-8058-13

SURFACE ELEVATION: DATE: 01-29-90

SAMPLE AND TYPE		DEPTH	LEGEND	SOIL DESCRIPTION		PENETRATION BLOWS FOR 6"
				~~3"~~	~~Asphalt, sandy gravel fill~~	
		1		9"	Moist, slightly plastic, very sandy clay fill very oxidized brown	
		2				
		3		3'0"	Very stiff, moist, plastic, silty clay, oxidized brown with interlaced white chalky material	
		4				
		5				
		6		5'0"	EOB	
		7			Soil Clay Interface at 3'0"	
		8			*Repeat Drive A' necessary to obtain sufficient sample volume for chemical analyses	
		9				
		10			*Repeat Drive B' made in second boring 1'0" south of initial boring in order to collect additional sample volume for chemical analyses from soil clay interface depth	
		11				
		12				
		13				
		14				
		15				
		16				
		17				
		18				
		19				
		20				
		21				
		22				
		23				
		24				
		25				

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: 0'9"
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: RS-34

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road
Highland, Michigan

NO.: 201-8058-13

SURFACE ELEVATION: ___ DATE: ___

SAMPLE AND TYPE		DEPTH	LEGEND	SOIL DESCRIPTION		PENETRATION BLOWS FOR 6"
				6"	Asphalt sandy clay fill	
A		1		1'0"	Soft, moist, oxidized brown silty clay fill, plastic with trace of very oxidized brown sandy clay	
		2				
B		3		3'0"	Very stiff, moist, plastic silty clay, oxidized brown with interlacing of white chalky material	
		4				
C		5				
		6		6'0"	EOB	
		7			Soil Clay Interface at 3'0"	
		8			*Repeat Drives A' and A" necessary to collect sufficient sample volume for chemical analyses	
		9				
		10				
		11				
		12				
		13				
		14				
		15				
		16				
		17				
		18				
		19				
		20				
		21				
		22				
		23				
		24				
		25				

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: 0'6"
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: ST01

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road

Highland, Michigan

NO.: 201-8058-13

SURFACE ELEVATION: [illegible] DATE: 01-30-90

SAMPLE AND TYPE		DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
				6" Asphalt wet sandy loose gravel fill with trace asphalt	
A		1		1'0" Very stiff, moist, very plastic silty clay oxidized brown interlaced with white chalky material with trace gravel and vegetation (reddish tint)	
		2			
B		3			
		4			
C		5		5'0"	
		6		Soil Clay Interface at 1'0"	
		7		*Repeated Drives A' and A" necessary to collect sufficient sample volume for chemical analyses	
		8			
		9			
		10			
		11			
		12			
		13			
		14			
		15			
		16			
		17			
		18			
		19			
		20			
		21			
		22			
		23			
		24			
		25			

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: 0'9"
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: ST 2

PROJECT: Hi Mill Manufacturing Co. RI/FS

NO.: 201-8058-13

LOCATION: 1704 Highland Road
Highland, Michigan

SURFACE ELEVATION: ____ DATE: 01-30-90

SAMPLE AND TYPE		DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
				6" Asphalt	
A		1		1'3" Wet loose, sandy gravel fill, trace gravel and brick	
		2			
B		3		Very stiff, moist, very plastic, silty clay oxidized brown interlaced with white chalky material, trace vegetation with with very moist brown clayey silt lamina	
		4			
C		5			
		6		6'0" EOB	
		7		Soil Clay Interface at 1'3"	
		8		Repeat Drives A', A" and A'" necessary in order to obtain sufficient sample volume for chemical analyses. Sample from A'" Drive was submitted for chemical analyses (HMS-ST12-2 and HMS-ST12-D) Drive 'A'" was collected from a second boring located 14" south from the first.	
		9			
		10			
		11			
		12			
		13			
		14			
		15			
		16			
		17			
		18			
		19			
		20			
		21			
		22			
		23			
		24			
		25			

TYPE OF SAMPLE	REMARKS	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE S.S. - SPLIT SPOON	REMARKS: Logged by G. DeWitt Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT: 0'9" G.W. ENCOUNTERED AT: ____

TECHNA CORPORATION

LOG OF SOIL BORING: ST13

PROJECT: Hi Mill Manufacturing Co. RI/FS

NO.: 201-8058-13

LOCATION: 1704 Highland Road
Highland, Michigan

SURFACE ELEVATION: [illegible] DATE: 01-30-90

SAMPLE AND TYPE	DEPTH	LEGEND		SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
			6"	Asphalt	
A	1			Wet loose sandy gravel fill trace gravel	
	2			Loose moist oxidized clayey sand trace gravel medium to fine with very thin beds of oxidized sandy clay and grey Silty clay	
B	3		3'6"		
	4				
	5				
	6			Very stiff moist plastic silty clay oxidized brown interlaced with white chalky material, trace vegetation with very moist brown clayey silt lamina	
C	7				
	8		8'0"	EOB	
	9			Soil Clay Interface at 3'6"	
	10			*Repeat Drives A' and A" as necessary in order to obtain sufficient sample for chemical analyses	
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				
	21				
	22				
	23				
	24				
	25				

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: None
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: ST34

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road
Highland, Michigan

NO.: 201-8058-13

SURFACE ELEVATION: [illegible] DATE: 01-30-90

SAMPLE AND TYPE		DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
				6" Asphalt	
~~A~~		1		1'0" Loose wet sandy gravel fill, trace gravel	
		2		2'0" Medium stiff, moist, plastic variegated oxidized brown and grey silty clay fill, trace fill	
~~B~~		3		Very stiff, moist, plastic silty clay, grey, oxidized brown with interlacing of white chalky material with thin lamina of brownish tan clayey silt very moist	
		4			
		5			
~~C~~		6		6'6" EOB	
		7		Soil Clay Interface 2'3"	
		8		*Drives A' and A" were necessary in order to obtain sufficient sample volume for chemical analyses	
		9			
		10			
		11			
		12			
		13			
		14			
		15			
		16			
		17			
		18			
		19			
		20			
		21			
		22			
		23			
		24			
		25			

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: 0'11"
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: WV01

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road

Highland, Michigan

NO.: 201-8058-13

SURFACE ELEVATION: [illegible] DATE: 01-31-90

SAMPLE AND TYPE		DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
				6" Asphalt	
A		1		Moist very soft brown fine sandy clay fill with trace gravel and silt	
		2			
B		3		Same	
		4		Same wet	
				4'9" Wet brown sandy clayey silt with trace gravel	
C		5		5'0" Very soft moist variegated organic blue and oxidized brown silty clay fill with trace peat and vegetation	
		6		5'8" Grey clayey sand fill with trace of silt very moist	
				6'2" Very stiff moist very plastic variegated clay oxidized brown and grey with trace silt and white chalky material interlaced thin lamina of greyish tan silt and trace vegetation	
D		7			
		8			
E		9		9'6" EOB	
		10		Soil Clay Interface at 6'2"	
		11		Repeat Drive B' necessary in order to obtain sufficient sample volume for chemical analyses. Drive B' made in second boring located 15" NE of original WV01 boring.	
		12			
		13			
		14			
		15			
		16			
		17			
		18			
		19			
		20			
		21			
		22			
		23			
		24			
		25			

TYPE OF SAMPLE	REMARKS	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE S.S. - SPLIT SPOON	REMARKS: Logged by G. DeWitt Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT: ____ G.W. ENCOUNTERED AT: ____

TECHNA CORPORATION

LOG OF SOIL BORING: YX01

PROJECT: Hi Mill Manufacturing Co. RI/FS

NO.: 201-8058-13

LOCATION: 1704 Highland Road
Highland, Michigan

SURFACE ELEVATION: DATE: 01-30-90

SAMPLE AND TYPE	DEPTH	LEGEND	PENETRATION BLOWS FOR 6"
	1		
A	2		
B	3		
	4		
C	5		
	6		
D	7		
	8		
E	9		
	10		
	11		
	12		
	13		
	14		
	15		
	16		
	17		
	18		
	19		
	20		
	21		
	22		
	23		
	24		
	25		

SOIL DESCRIPTION

4"	Asphalt
	Loose, very moist, oxidized brown silty sand, little gravel with very thin bed of black asphaltic appearing material medium sand fill
8"	Same discolored dark grey silty sand fill
4'2"	Organic black peat very moist with gradaded contact to next layer
4'6"	Soft moist variegated organic blue and oxidized brown silty clay fill with trace peat and vegetation
5'4"	Very moist variegated oxidized brown and grey sandy clay, slightly plastic, stiff, trace vegetation
5'10"	Very stiff moist very plastic variegated clay oxidized brown and grey with trace silt and white chalky material interlaced, thin lamina of greyish tan silt and trace vegetation
9'6"	EOB

Soil Clay Interface at 5'10"

Repeat Drive A' and A" were necessary in order to obtain sufficient shample volume for chemical analyses

TYPE OF SAMPLE	REMARKS	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE S.S. - SPLIT SPOON	REMARKS: Logged by G. DeWitt Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT: 7'3" G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: YX12

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road
Highland, Michigan

NO.: 201-8058-13

SURFACE ELEVATION: DATE:

SAMPLE AND TYPE	DEPTH	LEGEND		SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
			2"	~~Asphalt~~	
	1		4"	Concrete	
			8"	Medium brown clayey sand very moist trace gravel	
A	2				
B	3				
	4				
C	5		5'0"	Same with trace clay very moist to wet	
	6				
D	7		7'0"	Moderately stiff, moist, variegated organic blue and oxidized brown silty clay fill plastic with trace peat and vegetation	
	8				
	9				
E	10			Very stiff to hold, slightly moist, very plastic variegated clay oxidized brown and grey with trace silt and white chalky material interlaced thin lamina of greyish silt and trace vegetation	
	11		11'0"	EOB	
	12			Soil Clay Interface at 7'0"	
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				
	21				
	22				
	23				
	24				
	25				

TYPE OF SAMPLE	REMARKS	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE S.S. - SPLIT SPOON	REMARKS: Logged by G. DeWitt Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT: 3'8" G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: XW01

PROJECT: Hi Mill Manufacturing Co. RI/FS

NO.: 201-8058-13

LOCATION: 1704 Highland Road
Highland, Michigan

SURFACE ELEVATION: [illegible] DATE: 01-31-90

SAMPLE AND TYPE		DEPTH	LEGEND		SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
				4"	Asphalt	
A		1				
		2		2'0"	Loose moist brown clayey medium sand with trace gravel and vegetation (coarse base fill sand)	
B		3			Same. Wet at end of drive	
		4				
C		5			Same. Clayey sand with trace silt and some gravel. Wet at end of drive.	
		6				
D		7		7'0"	Same moist to wet grey clayey sand fill fine with trace silt	
		8			Very still moist very plastic variegated clay oxidized brown and grey with trace silt and white chalky material interlaced thin lamina of greyish tan silt and trace vegetation	
		9				
E		10			Same	
		11		11'0"	EOB	
		12			Soil Clay Interface at 7'0"	
		13			*Repeat Drive A' was necessary in order to obtain sufficient sample volume for chemical analyses	
		14				
		15				
		16				
		17				
		18				
		19				
		20				
		21				
		22				
		23				
		24				
		25				

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: 4'0"
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: XW12

PROJECT: Hi Mill Manufacturing Co. RI/FS

NO.: 201-8058-13

LOCATION: 1704 Highland Road
Highland, Michigan

SURFACE ELEVATION:

DATE: 01-31-90

SAMPLE AND TYPE	DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
			2" Asphalt	
A	1		4" Concrete 6" Void Grey cemented silt and grey silty clay fill slightly plastic, very moist and medium brown sand trace gravel	
	2			
B	3		Alternating thin beds of fine clay fill and medium sand described above continues to 6'6" with grey cemented silt continued to near surface	
	4			
C	5			
	6		6'6" Very stiff moist very plastic variegated clay oxidized brown and grey with trace silt and white chalky material interlaced thin lamina of greyish tan silt and trace vegetation	
	7			
	8			
	9			
E	10		10'6" EOB	
	11		Soil Clay Interface at 6'6"	
	12			
	13			
	14			
	15			
	16			
	17			
	18			
	19			
	20			
	21			
	22			
	23			
	24			
	25			

TYPE OF SAMPLE	REMARKS	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE S.S. - SPLIT SPOON	Logged by G. DeWitt Standard Penetration Test - Driving 2" OD Sampler 1' With 140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT: 3'6" G.W. ENCOUNTERED AT:

TECHNA CORPORATION

LOG OF SOIL BORING: ZY01

PROJECT: Hi Mill Manufacturing Co. RI/FS

NO.: 201-8058-13

LOCATION: 1704 Highland Road
Highland, Michigan

SURFACE ELEVATION: ______ DATE: 01-30-90

SAMPLE AND TYPE	DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
			4" ~~Asphalt~~	
	1		1'0" Medium sand very moist oxidized brown with trace gravel and clay fine clayey sand oxidized brown with trace gravel, moist, medium dense	
A	2		2'0" Medium dense, very moist, very dark - appears discolored, fine	
B	3			
	4		4'2" Organic peat, very moist	
C	5		4'6" Soft, moist variegated organic blue and oxidized brown and grey, medium stiff slightly plastic	
	6		5'6" Sandy clay, very moist, variegated oxidized brown and grey, medium stiff slightly plastic	
D	7		6'6" Silty clay, very stiff, moist, very plastic variegated oxidized brown and grey with trace silt and white chalky material interlaced thin lamina of greyish tan silt and trace vegetation	
	8			
E	9			
	10		10'0"	
	11		Soil Clay Interface at 6'6"	
	12		*Repeat Drive A' was necessary in order to obtain sufficient sample volume for chemical analyses	
	13		**A second boring 17" NE from the first ZY01 boring was made in order to collect additional sample from 2'0"-2'6" for chemical analyses	
	14			
	15			
	16			
	17			
	18			
	19			
	20			
	21			
	22			
	23			
	24			
	25			

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: 8'0"
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT: ____

TECHNA CORPORATION

LOG OF SOIL BORING: ZY12

PROJECT: Hi Mill Manufacturing Co. RI/FS

LOCATION: 1704 Highland Road
Highland, Michigan

NO.: 201-8058-13

SURFACE ELEVATION: DATE: 01-31-90

SAMPLE AND TYPE	DEPTH	LEGEND	SOIL DESCRIPTION	PENETRATION BLOWS FOR 6"
			2" Asphalt	
	1		6" Concrete	
			8" Asphalt	
A	2		Medium dense, medium to fine brown clayey sand, very moist to wet, trace gravel, some oxidation (base coarse gravel)	
B	3		3'8" Same	
C	4			
	5		Soft very moist variegated organic blue and oxidized brown silty clay fill, slightly plastic to plastic with trace peat and vegetation	
D	6		Same	
	7		6'11" Grey sandy clay fill with trace silt, very moist, slightly plastic	
	8		Hard, slightly moist very plastic, variegated clay, more brown (with trace oxidation) and grey with trace of silt and trace of white chalky material interlaced with thin lamina of greyish tan silt and vegetation	
	9			
	10			
	11		11'0" EOB	
	12		Soil Clay Interface at 7'0"	
	13			
	14			
	15			
	16			
	17			
	18			
	19			
	20			
	21			
	22			
	23			
	24			
	25			

TYPE OF SAMPLE	REMARKS: Logged by G. DeWitt	GROUND WATER OBSERVATIONS
S.T. - SHELBY TUBE	Standard Penetration Test - Driving 2" OD Sampler 1' With	G.W. ENCOUNTERED AT: 8'0"
S.S. - SPLIT SPOON	140# Hammer Falling 30"; Count Made At 6" Intervals	G.W. ENCOUNTERED AT:

APPENDIX G

PHYSICAL SOIL CHARACTERISTIC AND SLUG TEST ANALYSIS RESULTS

Job No. 89-630

PERMEABILITY SUMMARY

Sample	Permeability
IW-4AD	1.4×10^{-6} cm/sec
SW-10C	1.05×10^{-7} cm/sec
SW-15A	4.95×10^{-7} cm/sec
SW-15C	7.46×10^{-8} cm/sec
IW-1C	1.14×15^{-2} cm/sec
IW-5A	1.39×10^{-7} cm/sec
IW-5C	6.98×10^{-3} cm/sec
DW-1P	2.41×10^{-5} cm/sec
DW-1Q	3.63×10^{-6} cm/sec
DW-1T	8.12×10^{-6} cm/sec
DW-2K (upper)	8.24×10^{-3} cm/sec
* DW-2K (lower)	1.12×10^{-3} cm/sec
DW-3C	1.44×10^{-2} cm/sec
DW-3D	1.96×10^{-3} cm/sec
DW-3F	1.67×10^{-7} cm/sec

* DUPLICATE

Job No. 89-630

ATTERBERG LIMITS RESULTS

SAMPLE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
DW-2GD	25.5	16.0	9.5
IW-4A	36.7	18.9	17.8
SW-7D	32.6	18.2	14.4
IW-4AD	42.9	20.8	22.1
DW-2A	36.9	20.1	19.5
IW-5A	31.1	16.5	14.6
SW-22A	32.2	17.8	14.4
SW-10C	36.0	25.5	10.5

SIEVE ANALYSIS

BORING NUMBER	SAMPLE	% PASSING #40 SIEVE	% PASSING #60 SIEVE	% PASSING #100 SIEVE	% PASSING #200 SIEVE
DW-2	E	26.3	15.2	9.0	6.4
DW-2	K	29.8	10.4	8.3	7.3
SW-10	C	96.6	94.6	92.6	91.4
SW-15	A	97.4	96.7	96.0	95.7
SW-15	C	88.1	84.5	82.3	97.6
IW-1	C	44.1	39.2	35.9	33.0
IW-5	A	93.7	92.4	91.4	90.3
IW-5	C	17.9	7.0	2.9	1.8
DW-1	P	99.7	98.9	92.9	59.7
DW-1	Q	98.5	97.1	93.1	72.7
DW-1	T	45.8	33.9	24.6	20.5
* DW-2	K (UPPER)	22.1	7.3	5.7	5.0
DW-2	L (LOWER)	31.4	16.1	12.3	10.3
DW-3	C	99.0	98.9	98.7	98.5
DW-3	D	86.4	75.6	67.3	62.6
DW-3	F	69.1	53.9	44.8	40.4

* DUPLICATE

MOISTURE SUMMARY

SAMPLE	DEPTH IN FEET	% MOISTURE
SW-7D	15	27
SW-10C TOP	6	22
SW-22A BOTTOM	3	15
IW-1C TOP	46	24
IW-4D	41	31
IW-4D DUPLICATE	41	31
IW-4G	47	22
IW-5D TOP	41	15
DW-2E	57	12
DW-2G	66	15
DW-2K	86	15

In-Situ Slug Test Parameters & Results

Well Number	Effective Screen Depth (Feet)	Well Penetration Depth (Feet)	Aquifer Thickness (Feet)	Conductivity (CM/SEC)	Transmissivity (CM*CM/SEC)
SW-4	NA	NA	NA	<.153E-04	<.234E-02
SW-8	5.0	5.0	5.0	.153E-04	.234E-02
SW-9A	0.5	1.5	1.5	.225E-02	.103E+00
SW-9A-D	0.5	1.5	1.5	.207E-02	.946E-01
SW-11	1.0	1.0	1.0	.373E-04	.114E-02
SW-15	5.0	5.0	5.0	.877E-04	.134E-01
SW-17	3.5	3.5	10.5	.946E-03	.303E+00
IW-1	5.0	5.0	23.0	.565E-03	.396E+00
IW-1-D	5.0	5.0	23.0	.686E-03	.481E+00
IW-2	5.0	13.5	26.0	.109E-01	.860E+01
IW-3	5.0	7.5	23.0	.469E-02	.328E+01
IW-4	5.0	6.5	23.0	.361E-02	.253E+01
IW-5	5.0	6.5	22.0	.947E-02	.635E+01
DW-1	5.0	15.0	16.0	.564E-03	.275E+00
DW-1-D	5.0	15.0	16.0	.569E-03	.278E+00
DW-2	5.0	4.5	5.0	.220E-02	.336E+00
DW-3	3.0	5.0	5.0	.104E-03	.158E-01

APPENDIX H

SUMMARY OF SHORT LIST METAL ANALYSIS RESULTS - SOILS

APPENDIX I

SUMMARY OF TAL INORGANIC ANALYSIS RESULTS - SOILS

SOILS: TALINOS DATABASE

AMPLE ID MS-0G1-0

ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM
11100.00 *	16.00 UN	3.20	61.40 B	0.47 B	0.63 U	4050.00 E*	18.80
COPPER	IRON	LEAD	MAGNESIUM	MAGNANESE	MERCURY	NICKEL	POTASSIUM
7.00 BEN*	15400.00 E	23.80	2860.00	239.00	0.11 U	14.90	469.00
SILVER	SODIUM	THALLIUM	VANADIUM	ZINC	CYANIDE		
2.80 UN	339.00 U	1.30 U	24.10	34.90	0.78 U		

AMPLE ID MS-0G2-0

ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM
9370.00 *	17.90 UN	3.20 BW	60.90 B	0.36 B	1.40 B	1460.00 BE*	16.70
COPPER	IRON	LEAD	MAGNESIUM	MAGNANESE	MERCURY	NICKEL	POTASSIUM
10.90 EN*	15100.00 E	33.40 S	2600.00	502.00	0.14 U	11.40 B	526.00
SILVER	SODIUM	THALLIUM	VANADIUM	ZINC	CYANIDE		
3.20 UN	381.00 U	1.40 U	23.90	41.30	0.88 U		

AMPLE ID MS-0G3-0

ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM
6980.00 *	14.90 UN	3.20	30.30 B	0.29 B	0.80 B	744.00 BE*	10.70
COPPER	IRON	LEAD	MAGNESIUM	MAGNANESE	MERCURY	NICKEL	POTASSIUM
8.00 EN*	10300.00 E	19.30	1610.00	223.00	0.13 U	11.00 B	496.00
SILVER	SODIUM	THALLIUM	VANADIUM	ZINC	CYANIDE		
2.60 UN	316.00 U	1.20 U	16.10	33.30	0.73 U		

SAMPLE ID HMS-0G4-0

ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM
9770.00 *	14.30 UN	3.40	48.70 B	0.35 B	1.30 B	8680.00 E*	18.00
COPPER	IRON	LEAD	MAGNESIUM	MAGNANESE	MERCURY	NICKEL	POTASSIUM
13.70 EN*	15000.00 E	17.50 S	4670.00	521.00	0.10 U	12.50	578.00
SILVER	SODIUM	THALLIUM	VANADIUM	ZINC	CYANIDE		
2.50 UN	303.00 U	1.10 U	23.90	55.50	0.70 U		

SAMPLE ID HMS-C4-0

ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM
8950.00 *	16.60 UN	3.30	52.90 B	0.34 B	1.00 B	1920.00 E*	14.30
COPPER	IRON	LEAD	MAGNESIUM	MAGNANESE	MERCURY	NICKEL	POTASSIUM
11.20 EN*	13100.00 E	21.10	2090.00	442.00	0.15 U	8.50 B	778.00
SILVER	SODIUM	THALLIUM	VANADIUM	ZINC	CYANIDE		
2.90 UN	352.00 U	1.30 U	20.90	44.60	0.81 U		

SAMPLE ID HMS-E5-0

ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM
11600.00 *	17.20 BN	3.90 S	60.20 B	0.44 B	1.40 B	3170.00 E*	16.50
COPPER	IRON	LEAD	MAGNESIUM	MAGNANESE	MERCURY	NICKEL	POTASSIUM
10.80 EN*	14800.00 E	9.20	2820.00	415.00	0.15 U	13.80	943.00
		THALLIUM	VANADIUM	ZINC	CYANIDE		

SOILS: TALINOS DATABASE

SAMPLE ID	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM
HMS-G3/H4-2	66.10 *	11.80 UN	5.00	23.50 B	0.29 B	0.85 B	64900.00 E*	118.00
	COPPER	IRON	LEAD	MAGNESIUM	MAGNANESE	MERCURY	NICKEL	POTASSIUM
	222.00 en*	10800.00 E	7.10	12100.00	370.00	0.09 U	12.90	723.00
	SILVER	SODIUM	THALLIUM	VANADIUM	ZINC	CYANIDE		
	2.10 UN	250.00 U	0.92	16.10	73.10	0.58 U		

SAMPLE ID	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM
HMS-G4-2	2930.00 *	12.00 UN	4.20	10.00 B	0.24 U	0.52 B	112000.00 E*	8.70
	COPPER	IRON	LEAD	MAGNESIUM	MAGNANESE	MERCURY	NICKEL	POTASSIUM
	12.70 EN*	7520.00 E	4.40	14900.00	345.00	0.08 U	5.90 B	286.00
	SILVER	SODIUM	THALLIUM	VANADIUM	ZINC	CYANIDE		
	2.10 UN	255.00 U	0.94 U	8.50 B	25.80	0.59 U		

SAMPLE ID	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM
HMS-G4-2D	2850.00 *	13.40 BN	5.10	9.90 U	0.24 U	0.66 B	88500.00 E*	10.20
	COPPER	IRON	LEAD	MAGNESIUM	MAGNANESE	MERCURY	NICKEL	POTASSIUM
	0.00 EN*	6500.00 E	8.00	15200.00	222.00	0.10 U	9.00 B	284.00
	SILVER	SODIUM	THALLIUM	VANADIUM	ZINC	CYANIDE		
	2.10 UN	255.00 U	0.94 U	10.20 B	23.90	0.59 U		

SAMPLE ID	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM
HMS-G7-0	12100.00 *	128.00 UN	14.00 B	105.00 U	2.50 U	10.60 B	10700.00 BE*	139.00
	COPPER	IRON	LEAD	MAGNESIUM	MAGNANESE	MERCURY	NICKEL	POTASSIUM
	1480.00 EN*	18400.00 E	60.00	2270.00 B	764.00	0.86 U	27.50 U	1970.00
	SILVER	SODIUM	THALLIUM	VANADIUM	ZINC	CYANIDE		
	22.50 UN	2710.00 U	10.00 U	20.00 U	664.00	6.30 U		

SAMPLE ID	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM
HMS-H3/I4-2	10800.00	12.40 U	4.20	52.10	0.27 B	1.10 B	30900.00	89.50
	COPPER	IRON	LEAD	MAGNESIUM	MAGNANESE	MERCURY	NICKEL	POTASSIUM
	615.00	13700.00	15.40	9640.00	255.00	0.10 U	15.20	1090.00
	SILVER	SODIUM	THALLIUM	VANADIUM	ZINC	CYANIDE		
	2.20 U	349.00 B	0.97 U	23.30	84.50	0.61 U		

SAMPLE ID	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM
HMS-I4-2	11700.00 *	12.60 UN	6.20 S	62.50	0.46 B	0.50 U	28100.00 E*	30.70
	COPPER	IRON	LEAD	MAGNESIUM	MAGNANESE	MERCURY	NICKEL	POTASSIUM
	196.00 EN*	17400.00 E	22.50 +	10900.00	225.00	0.12 U	22.00	833.00
	SILVER	SODIUM	THALLIUM	VANADIUM	ZINC	CYANIDE		
					[illegible]	[illegible]		

SOILS: TALINOS DATABASE

AMPLE ID	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM
·S-L4-D	25200.00	16.30 U	2.40 B	202.00	0.95 B	2.40	8240.00	49.00
	COPPER	IRON	LEAD	MAGNESIUM	MAGNANESE	MERCURY	NICKEL	POTASSIUM
	182.00	25500.00	17.80	7200.00	190.00	0.14 U	29.70	1660.00
	SILVER	SODIUM	THALLIUM	VANADIUM	ZINC	CYANIDE		
	2.90 U	453.00 B	1.30 U	39.40	81.10	0.80 U		

AMPLE ID	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM
·S-YX12-2	18300.00 *	13.10 UN	2.30 B	144.00	0.86 B	1.30	21900.00 E*	38.90
	COPPER	IRON	LEAD	MAGNESIUM	MAGNANESE	MERCURY	NICKEL	POTASSIUM
	135.00 EN*	18600.00 E	14.20	10100.00	146.00	0.13 U	23.60	856.00
	SILVER	SODIUM	THALLIUM	VANADIUM	ZINC	CYANIDE		
	2.30 UN	278.00 U	1.00 U	36.00	46.90	0.64 U		

APPENDIX J

SUMMARY OF TCL VOLATILE ORGANIC ANALYSIS RESULTS (SPECIES DETECTED) - GROUNDWATER

VOAGW DATABASE

ENCOTECNO	SAMPLEID	COMPOUND	CAS	AMOUNT	FLAG
E49374	HMS-DW01	Methylene chloride	75-09-2	0.014	B
E49374	HMS-DW01	2-Butanone	78-93-3	0.007	J
E49374	HMS-DW01	Acetone	67-64-1	0.022	B
E49306	HMW-DW02	Toluene	108-88-3	0.001	JB
E49306	HMW-DW02	Methylene chloride	75-09-2	0.045	B
E49306	HMW-DW02	Acetone	67-64-1	0.016	B
E49310	HMW-DW02-FB	Methylene chloride	75-09-2	0.005	B
E49310	HMW-DW02-FB	Acetone	67-64-1	0.029	B
E49308	HMW-DW02-MS	Acetone	67-64-1	0.024	B
E49308	HMW-DW02-MS	Methylene chloride	75-09-2	0.004	JB
E49701	HMW-DW03 AND MATRIX	Methylene chloride	75-09-2	0.007	
E49233	HMW-IW01	Methylene chloride	75-09-2	0.002	JB
E49233	HMW-IW01	Toluene	108-88-3	0.003	JB
E49697	HMW-IW02	Methylene chloride	75-09-2	0.008	
E49309	HMW-IW03	Acetone	67-64-1	0.018	B
E49309	HMW-IW03	Methylene chloride	75-09-2	0.010	B
E49227	HMW-IW04	Acetone	67-64-1	0.003	JB
E49227	HMW-IW04	2-Butanone	78-93-3	0.005	JB
E49227	HMW-IW04	Methylene chloride	75-09-2	0.008	B
E49705	HMW-IW05	Methylene chloride	75-09-2	0.017	
E49167	HMW-SW01	Trichloroethene	79-01-6	1.100	
E49167	HMW-SW01	Methylene chloride	75-09-2	0.100	B
E49167	HMW-SW01	1,2-Dichloroethene (Total)	540-59-0	0.360	
E49167	HMW-SW01	2-Butanone	78-93-3	0.090	JB
E49167	HMW-SW01	Acetone	67-64-1	0.160	B
E49168	HMW-SW02	Methylene chloride	75-09-2	0.010	B
E49165	HMW-SW03	Vinyl chloride	75-01-4	0.068	
E49165	HMW-SW03	Acetone	67-64-1	0.046	B
E49165	HMW-SW03	2-Butanone	78-93-3	0.018	JB
E49165	HMW-SW03	Trichloroethene	79-01-6	0.014	
E49165	HMW-SW03	Methylene chloride	75-09-2	0.026	B
E49165	HMW-SW03	1,2-Dichloroethene (Total)	540-59-0	0.180	
E49131	HMW-SW04	2-Butanone	78-93-3	0.015	B
E49131	HMW-SW04	Toluene	108-88-3	0.003	J
E49131	HMW-SW04	Methylene chloride	75-09-2	0.004	JB
E49132	HMW-SW05	Vinyl chloride	75-01-4	0.004	J
E49132	HMW-SW05	Methylene chloride	75-09-2	0.009	B
E49132	HMW-SW05	1,2-Dichloroethene (Total)	540-59-0	0.075	
E49132	HMW-SW05	Acetone	67-64-1	0.027	B
E49133	HMW-SW05-D	1,2-Dichloroethene (Total)	540-59-0	0.068	
E49133	HMW-SW05-D	Methylene chloride	75-09-2	0.009	B
E49133	HMW-SW05-D	Vinyl chloride	75-01-4	0.003	J
E49133	HMW-SW05-D	2-Butanone	78-93-3	0.028	B
E49133	HMW-SW05-D	Acetone	67-64-1	0.033	B
E49134	HMW-SW06	Methylene chloride	75-09-2	0.009	B
E49134	HMW-SW06	Acetone	67-64-1	0.006	JB
E49134	HMW-SW06	2-Butanone	78-93-3	0.001	JB
E49135	HMW-SW06-FB	Acetone	67-64-1	0.017	B
E49135	HMW-SW06-FB	Methylene chloride	75-09-2	0.009	B
E49135	HMW-SW06-FB	2-Butanone	78-93-3	0.004	JB
E49136	HMW-SW08	Methylene chloride	75-09-2	0.007	B
E49228	HMW-SW10	Methylene chloride	75-09-2	0.006	B
E49228	HMW-SW10	1,2-Dichloroethene (Total)	540-59-0	0.030	
E49228	HMW-SW10	2-Butanone	78-93-3	0.004	JB
E49228	HMW-SW10	Acetone	67-64-1	0.002	JB
E49229	HMW-SW10-D	Methylene chlori[illegible]	75-09-2	0[illegible]3	B
E49229	HMW-SW10-D	Acetone	67-64-1	0.[illegible]5	B

ENCOTECNO	SAMPLEID	COMPOUND	CAS	AMOUNT	FLAG
E49. J	HMW-SW10-D	1,2-Dichloroe ene (Total)	540-59-0	0.035	
E49230	HMW-SW10-MS	Methylene chloride	75-09-2	0.002	JB
E49230	HMW-SW10-MS	Toluene	108-88-3	0.002	JB
E49230	HMW-SW10-MS	1,2-Dichloroethene (Total)	540-59-0	0.029	
E49230	HMW-SW10-MS	Acetone	67-64-1	0.006	JB
E49049	HMW-SW11	Toluene	108-88-3	0.003	JB
E49049	HMW-SW11	Methylene chloride	75-09-2	0.005	B
E49232	HMW-SW12	Toluene	108-88-3	0.003	JB
E49232	HMW-SW12	2-Butanone	78-93-3	0.006	JB
E49232	HMW-SW12	Methylene chloride	75-09-2	0.002	JB
E49232	HMW-SW12	Acetone	67-64-1	0.011	B
E49048	HMW-SW20	Methylene chloride	75-09-2	0.005	B
E49048	HMW-SW20	Acetone	67-64-1	0.017	B
E49048	HMW-SW20	2-Butanone	78-93-3	0.010	B
E49048	HMW-SW20	Toluene	108-88-3	0.003	JB
E49706	HMW-SW22	Methylene chloride	75-09-2	0.020	
E49707	HMW-SW22-D	Methylene chloride	75-09-2	0.023	
E49708	HMW-SW22-FB	Methylene chloride	75-09-2	0.029	
E49708	HMW-SW22-FB	Acetone	67-64-1	0.009	J
E49050	HMW-TB-03/15/90	Methylene chloride	75-09-2	0.011	B
E49050	HMW-TB-03/15/90	Toluene	108-88-3	0.003	JB
E49050	HMW-TB-03/15/90	2-Butanone	78-93-3	0.004	JB
E49139	HMW-TB-03/16/90	Toluene	108-88-3	0.001	J
E49139	HMW-TB-03/16/90	Acetone	67-64-1	0.011	B
E49139	HMW-TB-03/16/90	2-Butanone	78-93-3	0.004	JB
E49139	HMW-TB-03/16/90	Methylene chloride	75-09-2	0.016	B
E49171	HMW-TB-03/19/90	2-Butanone	78-93-3	0.004	JB
E49171	HMW-TB-03/19/90	Acetone	67-64-1	0.012	B
E49171	HMW-TB-03/19/90	Trichloroethene	79-01-6	0.001	J
E49171	HMW-TB-03/19/90	Methylene chloride	75-09-2	0.012	B
E49050	HMW-TB-03/19/90	Acetone	67-64-1	0.012	B
E49235	HMW-TB-03/20/90	Toluene	108-88-3	0.002	JB
E49235	HMW-TB-03/20/90	Methylene chloride	75-09-2	0.003	JB
E49235	HMW-TB-03/20/90	Acetone	67-64-1	0.008	JB
E49235	HMW-TB-03/20/90	2-Butanone	78-93-3	0.004	JB
E49311	HMW-TB-03/21/90	Acetone	67-64-1	0.013	B
E49311	HMW-TB-03/21/90	Methylene chloride	75-09-2	0.012	B
E49311	HMW-TB-03/21/90	Toluene	108-88-3	0.001	J
E49375	HMW-TB-03/22/90	Acetone	67-64-1	0.013	B
E49375	HMW-TB-03/22/90	Methylene chloride	75-09-2	0.014	B
E49695	HMW-TB-03/23/90	Acetone	67-64-1	0.011	
E49695	HMW-TB-03/23/90	Methylene chloride	75-09-2	0.014	

APPENDIX K

SUMMARY OF TAL INORGANIC ANALYSIS RESULTS (SPECIES DETECTED) - GROUNDWATER

GROUNDWATER: TALINOGW DATABASE

MPLE ID								
W-SW8	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM
	85.00 U	51.00 U	3.00 UW	B	1.00 U	2.00 U	305000.00	12.80
	COPPER	IRON	LEAD	MAGNESIUM	MAGNANESE	MERCURY	NICKEL	POTASSIUM
	10.00 U	39.30 B	2.00 U	170000.00	509.00	0.20 U	11.00 U	1130.00
	SILVER	SODIUM	THALLIUM	VANADIUM	ZINC	CYANIDE		
	9.00 U	97600.00	4.00 UW	8.00 U	6.00 U	10.00 U		
MPLE ID								
W-SW8-D	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM
	85.00 U	51.00 U	3.00 UW	B	1.00 U	2.00 U	294000.00	15.10
	COPPER	IRON	LEAD	MAGNESIUM	MAGNANESE	MERCURY	NICKEL	POTASSIUM
	10.00 U	77.90 B	2.00 U	164000.00	503.00	0.20 U	11.00 U	1120.00
	SILVER	SODIUM	THALLIUM	VANADIUM	ZINC	CYANIDE		
	9.00 U	107000.00	4.00 UW	8.00 U	6.00 U	10.00 U		
MPLE ID								
W-SW8-FB	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM
	85.00 U	51.00 U	3.00 UW	U	1.00 U	2.00 U	1330.00 U	21.90
	COPPER	IRON	LEAD	MAGNESIUM	MAGNANESE	MERCURY	NICKEL	POTASSIUM
	10.00 U	39.00 U	2.20 B	848.00 U	5.00 U	0.20 U	11.00 U	788.00
	SILVER	SODIUM	THALLIUM	VANADIUM	ZINC	CYANIDE		
	10.90	1080.00 U	4.00 U	8.00 U	6.00 U	0.00		

SAMPLE ID	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM
IMW-IW1	85.00 U	51.00 U	3.00 UW	U	1.00 U	2.00 U	138000.00	20.70
	COPPER	IRON	LEAD	MAGNESIUM	MAGNANESE	MERCURY	NICKEL	POTASSIUM
	10.00 U	47.80 B	2.00 U	35600.00	497.00	0.20 U	11.00 U	1980.00
	SILVER	SODIUM	THALLIUM	VANADIUM	ZINC	CYANIDE		
	9.00 U	19400.00	4.00 UW	9.00 U	6.00 U	10.00 U		
SAMPLE ID	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM
IMW-IW3	85.00 U	51.00 U	3.00 UW	U	1.00 U	2.00 U	69700.00	16.00
	COPPER	IRON	LEAD	MAGNESIUM	MAGNANESE	MERCURY	NICKEL	POTASSIUM
	10.00 U	391.00	2.00 U	18000.00	57.80	0.20 U	11.00 U	5610.00
	SILVER	SODIUM	THALLIUM	VANADIUM	ZINC	CYANIDE		
	9.00 U	10300.00	4.00 UW	8.00 U	6.00 U	10.00 U		
SAMPLE ID	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM
IMW-IW5	114.00 U	56.00 U	3.00 U	B	2.00 U	2.00 U	72300.00	9.00
	COPPER	IRON	LEAD	MAGNESIUM	MAGNANESE	MERCURY	NICKEL	POTASSIUM
	11.00 U	67.00 B	2.50 B	19100.00	49.20	0.20 U	19.00 U	962.00
	SILVER	SODIUM	THALLIUM	VANADIUM	ZINC	CYANIDE		
	8.00 U	4220.00 B	4.00 U	10.90 B	5.00 U	0.00		
SAMPLE ID	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM
IMW-SW2	85.00 U	51.00 U	3.00 UW	U	1.00 U	2.00 U	59000.00	30.20
	COPPER	IRON	LEAD	MAGNESIUM	MAGNANESE	MERCURY	NICKEL	POTASSIUM
	10.00 U	87.90 B	2.00 U	20300.00	65.10	0.20 U	11.00 U	905.00
	SILVER	SODIUM	THALLIUM	VANADIUM	ZINC	CYANIDE		
	9.00 U	3450.00 B	4.00 U	8.00 U	6.00 U	10.00 U		
SAMPLE ID	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM
IMW-SW22	208.00	56.00 U	3.00 UW	U	2.00 U	2.00 U	280000.00	9.00
	COPPER	IRON	LEAD	MAGNESIUM	MAGNANESE	MERCURY	NICKEL	POTASSIUM
	11.00 U	29.00 U	2.00 U	529000.00	110.00	0.20 U	20.30 B	962.00
	SILVER	SODIUM	THALLIUM	VANADIUM	ZINC	CYANIDE		
	8.00 U	81400.00	4.00 UW	8.00 U	5.00 U	0.00		
SAMPLE ID	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM
IMW-SW5	85.00 U	51.00 U	3.00 UW	U	1.00 U	2.00 U	223000.00	21.10
	COPPER	IRON	LEAD	MAGNESIUM	MAGNANESE	MERCURY	NICKEL	POTASSIUM
	10.00 U	39.00 U	2.00 U	38600.00	811.00	0.20 U	11.00 U	11500.00
	SILVER	SODIUM	THALLIUM	VANADIUM	ZINC	CYANIDE		
	9.00 U	579000.00	4.00 UW	8.00 U	6.00 U	37.00		

APPENDIX L

SUMMARY OF SHORT LIST METALS ANALYSIS RESULTS - GROUNDWATER

GROUNDWATER: [illegible] TOT METALS CONCENTRATIONS

SAMPLE ID	ALUMINUM	CHROMIUM	COPPER	NICKEL	SILVER	ZINC
HMW-DWC1	85.00 U	7.00 U	10.00 U	11.00 U	9.00 UN	6.00 U
HMW-DWC2	85.00 U	7.00 U	10.00 U	11.00 U	9.00 UN	6.00 U
HMW-DWC2-D	85.00 U	7.00 U	10.00 U	11.00 U	9.00 UN	6.00 U
HMW-DWC3	114.00 U	9.00 U	11.00 U	19.00 U	8.00 U	5.00 U
HMW-EWC1	114.00 U	9.00 U	11.30 B	19.00 U	8.00 U	8.00 B
HMW-EWC2	114.00 U	9.00 U	11.00 U	19.00 U	8.00 U	5.00 U
HMW-EWC2-D	114.00 U	9.00 U	11.00 U	19.00 U	8.00 U	5.00 U
HMW-EWC4	114.00 U	9.00 U	13.30 B	19.00 U	8.00 U	5.00 U
HMW-EWC4-FB	114.00 U	9.00 U	11.00 U	19.00 U	8.00 U	5.00 U
HMW-EWC6	85.00 U	7.00 U	10.00 U	11.00 U	9.00 UN	6.00 U
HMW-EWC6-FB	114.00 U	9.00 U	11.00 U	19.00 U	8.00 U	5.00 U
HMW-IWC1	85.00 U	20.70 *	10.00 U	11.00 U	9.00 U	6.00 U
HMW-IWC2	114.00 U	9.00 U	11.00 U	19.00 U	8.00 U	5.00 U
HMW-IWC3	85.00 U	16.00 *	10.00 U	11.00 U	9.00 U	6.00 U
HMW-IWC4	85.00 U	7.00 U	10.00 U	11.00 U	9.00 UN	6.00 U
HMW-IWC5	114.00 U	9.00 U	11.00 U	19.00 U	8.00 U	5.00 U
HMW-SWC1	85.00 U	7.00 U	10.00 U	17.90 B	9.00 UN	6.00 U
HMW-SWC2	85.00 U	30.20 *	10.00 U	11.00 U	9.00 U	6.00 U
HMW-SWC2	85.00 U	30.20 *	10.00 U	11.00 U	9.00 U	6.00 U
HMW-SWC3	85.00 U	7.00 U	10.00 U	11.00 U	9.00 UN	6.00 U
HMW-SWC4	85.00 U	7.00 U	10.00 U	29.80 B	9.00 UN	6.00 U
HMW-SWC5	85.00 U	21.10 *	10.00 U	11.00 U	9.00 U	6.00 U
HMW-SWC5	85.00 U	21.10 *	10.00 U	11.00 U	9.00 U	6.00 U
HMW-SWC6	85.00 U	7.00 U	10.00 U	11.00 U	9.00 UN	6.00 U
HMW-SWC6-FB	85.00 U	7.00 U	10.00 U	11.00 U	9.00 UN	6.00 U
HMW-SWC7	85.00 U	7.00 U	93.30	34.30 B	9.00 UN	22.20
HMW-SWC7-D	85.00 U	7.00 U	98.70	30.20 B	9.00 UN	19.30 B
HMW-SWC8	85.00 U	12.80 *	10.00 U	11.00 U	9.00 U	6.00 U
HMW-SWC8	85.00 U	12.30 *	10.00 U	11.00 U	9.00 U	6.00 U
HMW-SWC8-D	85.00 U	15.10 *	10.00 U	11.00 U	9.00 U	6.00 U
HMW-SWC8-D	85.00 U	15.10 *	10.00 U	11.00 U	9.00 U	6.00 U
HMW-SWC8-FB	85.00 U	21.90 *	10.00 U	11.00 U	10.90	6.00 U
HMW-SWC8-FB	85.00 U	21.90 *	10.00 U	11.00 U	10.90	6.00 U
HMW-SWC9A	114.00 U	9.00 U	16.30 B	19.00 U	8.00 U	5.10 B
HMW-SWC9A-FB	114.00 U	9.00 U	11.00 U	19.00 U	8.00 U	5.00 U
HMW-SW10	85.00 U	7.00 U	33.80	15.60 B	9.00 UN	6.00 U
HMW-SW11	85.00 U	7.00 U	10.00 UN	19.00 U	9.00 UN	6.00 U
HMW-SW12	85.00 U	7.00 U	10.00 U	11.00 U	9.00 UN	6.00 U
HMW-SW14	85.00 U	7.00 U	10.00 U	11.00 U	9.00 UN	6.00 U
HMW-SW15	85.00 U	45.80	10.00 UN	19.00 U	9.00 UN	6.00 U
HMW-SW17	85.00 U	7.00 U	10.00 U	11.00 U	9.00 UN	6.00 U
HMW-SW18	85.00 U	7.40 B	10.00 U	11.00 U	9.00 UN	6.00 U
HMW-SW19	85.00 U	7.00 U	10.00 UN	19.00 U	9.00 UN	7.20 B
HMW-SW20	648.00	9.00 B	10.00 UN	19.00 U	14.60 N	22.10
HMW-SW21	85.00 U	7.00 U	10.00 U	11.00 U	9.00 UN	6.00 U
HMW-SW22	208.00	9.00 U	11.00 U	20.30 B	8.00 U	5.00 U
HMW-SW22	208.00	9.00 U	11.00 U	20.00 B	8.00 U	5.00 U

APPENDIX M

SUMMARY OF AMMONIA AND NITRATE/NITRITE ANALYSIS RESULTS - GROUNDWATER

NPNGW DATABASE

SAMPLEID	AMCONC	AMFLAG	NPNCONC	NPNFLAG
HMW-SW01	150.00	AC	50.00	UAC
HMW-SW02	50.00	AC	50.00	UAC
HMW-SW03	310.00	AC	50.00	AC
HMW-SW04	190.00	AC	120.00	AC
HMW-SW05	1000.00	AC	16000.00	AC
HMW-SW06	50.00	UAC	50.00	AC
HMW-SW07	2100.00	AC	1500.00	AC
HMW-SW08	320.00	AC	230.00	AC
HMW-SW08-D	300.00	AC	200.00	AC
HMW-SW08-FB	50.00	UAC	50.00	UAC
HMW-SW10	1200.00	AC	110.00	AC
HMW-SW11	50.00	UAC	50.00	AC
HMW-SW12	50.00	UAC	50.00	UAC
HMW-SW14	80.00	AC	50.00	UAC
HMW-SW15	50.00	UAC	460.00	AC
HMW-SW17	100.00	UAC	290.00	AC
HMW-SW17-D	130.00	AC	310.00	AC
HMW-SW18	50.00	UAC	190.00	AC
HMW-SW19	70.00	AC	840.00	AC
HMW-SW20	50.00	UAC	50.00	UAC
HMW-SW21	2200.00	AC	50.00	UAC
HMW-SW22	50.00	AC	150.00	AC
HMW-SW22-FB	50.00	UAC	50.00	UAC

APPENDIX N

SUMMARY OF TEMPERATURE, SPECIFIC CONDUCTIVITY AND PH MEASUREMENT - GROUNDWATER

Well No.	pH (Standard Units)	Temperature (°C)	Conductivity (Standard Units)	Measured: Field	Lab	Sample Date
SW-1	7.38	7.8	960	✓		3-19-90
SW-2	7.99	7.8	380	✓		3-19-90
SW-3	7.05	5.5	970	✓		3-19-90
SW-4	7.14	7.2	2120	✓		3-16-90
SW-5	7.57	9.4	1750	✓		3-16-90
SW-6	6.91	8.9	2620	✓		3-16-90
SW-7	5.7	8.3	2610	✓		3-17-90
SW-8	5.6	8.3	2490	✓		3-16-90
SW-9	6.79	8.3	480	✓		3-20-90
SW-9A	6.76	6.5	532		✓	4-12-90
SW-10	7.10	4.4	1340	✓		3-20-90
SW-11	5.0	12.8	780	✓		3-15-90
SW-12	7.4	4.4	730	✓		3-20-90
SW-14	5.18	10.6	1260	✓		3-20-90
SW-15	5.5	12.8	480	✓		3-15-90
SW-17	8.48	8.3	600	✓		3-20-90
SW-18	6.33	6.7	390	✓		3-20-90
SW-19	5.82	12.8	560	✓		3-14-90
SW-20	4.8	12.8	1850	✓		3-15-90
SW-21	7.22	5.0	1520	✓		3-19-90
SW-22	7.82	1.7	3570		✓	3-23-90
IW-1	7.0	12.2	1020	✓		3-20-90
IW-2	7.88	5.0	368		✓	3-23-90
IW-3	N/A	9.4	650	✓		3-21-90
IW-4	6.96	8.3	670	✓		3-20-90
IW-5	7.80	8.9	414		✓	3-23-90
DW-1	7.89	9.4	400		✓	3-22-90
DW-2	6.9	10.0	730	✓		3-21-90
DW-3	8.17	9.4	391		✓	3-23-90
EW-1	7.16	5.0	898		✓	3-23-90
EW-2	8.15	3.3	1648		✓	3-23-90
EW-4	7.41	3.3	1174		✓	3-23-90
EW-6	7.15	3.9	521		✓	3-22-90

APPENDIX O

MDNR BIOLOGICAL, SURFACE WATER AND SEDIMENT SURVEY

KS-8410-050

REFERENCE 10

SITE NAME Hi-Mill Manu

SITE ID MID005341714

RECEIVED

MAR 06 1985

WATER QUALITY DIV. DIST. I

Michigan Department of Natural Resources
Surface Water Quality Division
Water Quality Surveillance Section
February 1985

A Biological and Water and Sediment Chemistry Survey of Waterbury Lake and Adjacent Marsh Oakland County, Michigan April 26, 1984

Introduction

Surface Water Quality Division staff of the Water Quality Surveillance Section surveyed Waterbury Lake and a marsh east of Hi Mill Manufacturing Company to determine the potential impact of Hi Mill Manufacturing Company discharge on these water bodies (Figure 1). The survey was performed at the request of Hakim Shakir, Detroit District Groundwater Quality Division staff in connection with the groundwater cleanup operation at Hi Mill Manufacturing.

Conclusions

1. Waterbury Lake was not connected with the marsh east of Hi Mill Manufacturing and was not impacted by Hi Mill Manufacturing surface water discharges.

2. Marsh waters generally contained higher concentrations of heavy metals than the background stations in Waterbury Lake.

3. Concentrations of copper in marsh waters exceeded the chronic criteria for warmwater species of freshwater aquatic life.

4. Sediment heavy metal concentrations in the marsh exceeded background concentrations in Waterbury Lake and in many cases mean concentrations downstream of industrial and municipal discharges.

5. Algae and zooplankton were abundant in marsh waters but bottom dwelling organisms were limited to pollution tolerant forms. The lack of additional species may be due to limited water in the dry season or the nutrient enriched condition of the marsh waters.

Recommendations

1. Minimize the sources of heavy metals entering the marsh from the Hi Mill parking lot and roof drainage system.

2. Continue to fill the existing lagoon.

3. Determine if contaminated groundwater should be purged.

Background

Hi Mill Manufacturing has an aluminum annodizing process and fabricates aluminum and copper parts. Process wastes are discharged to seepage lagoons adjacent to the marsh east of their property. In 1972 elevated levels of copper were found in the adjacent marshland and one of the company's drinking water wells (SWQD File, Hi Mill Mfg. Co.). In 1975 additional water samples collected in the marsh revealed elevated concentrations of nitrates, copper, aluminum, zinc and chromium. File reviews showed lagoon overflows had apparently been occurring and in April of 1978 additional water and sediment sampling was completed in the lagoon and marsh. Recommendations were made to remove lagoon wastes and sludges and fill the lagoon (Grant, 1978). None of the recommendations were accomplished, but no additional discharges were made to the lagoon after 1978. Hi Mill Manufacturing attempted to evaporate the lagoon liquid by spraying it into the air from the top of their building. This resulted in liquids entering the marsh through their roof and parking lot drain system. Groundwater samples collected in 1981 showed migration of elevated concentrations of aluminum, chromium, copper and zinc in the shallow water table (3 to 7 feet) and into the marsh (Sibo, 1982). As of November 1983, lagoon liquids and sludges had been removed and the lagoon itself was being filled.

Methods

Water and sediments for chemical analysis were collected and preserved according to "Quality Assurance for Water and Sediment Sampling" (MDNR 1981) and returned to the Environmental Laboratory in Lansing for analysis. Benthic macroinvertebrates were collected with a petite ponar dredge grab sampler and sieved through a number 30 mesh sieve. Organisms were identified with the naked eye on site and their abundance qualitatively assessed and recorded on stream problem assessment cards (Appendix A). Phytoplankton samples were qualitatively collected with a 64 micron mesh phytoplankton net towed at approximately a 45 degree angle, washed into a vial and returned to the Lansing Biological Laboratory and identified under the microscope at 400x power.

Water

Marshwater samples collected in 1984 contained lower concentrations of heavy metals than marshwaters at similar areas in 1978. However, concentrations of zinc, chromium, and copper were greater than those at the background location sampled in nearby Waterbury Lake. These data suggest that while heavy metal concentrations are decreasing in the marsh water they may still be leaching from the sediments into the water or continuing to enter from surface water discharges or contaminated groundwater. Neither chromium or zinc exceeded the criteria for freshwater aquatic life but the concentration of copper in the marsh water exceeded the chronic criteria (33 ug/l) for warmwater fish. Concentrations of total copper, zinc, chromium, and aluminum in the parking lot and roof drainage were lower than the mid-marsh samples taken in 1978, but higher than marsh samples collected in 1984 indicating a continuing source of metals to the marsh. The copper concentration in the parking lot and roof drainage water exceeded both the acute and the chronic criteria for aquatic life. Contaminated groundwater resulting from the old seepage lagoons may also be contributing to heavy metals concentrations in marsh waters.

Sediments

Heavy metals in marsh and parking lots and roof runoff drainage sediments were higher than sediments collected in nearby Waterbury Lake Station 4 (Table 2). Total aluminum, total copper, total zinc and total cadmium were an order of magnitude higher while total chromium was two orders of magnitude higher in the marsh than in Waterbury Lake. These data suggest direct inputs of these metals to the marsh system from Hi Mill Manufacturing Company. Sediment total iron, total arsenic, total lead, total manganese and total lithium were also higher in the marsh than in Waterbury Lake. Mercury was detected only in the parking lot and roof drain outfall sediments. Concentrations of heavy metals in the marsh exceed the average concentrations downstream of industrial and municipal locations (Hesse and Evans 1972). It is not known if these sediment metals are leaching into the water column or are causing toxicity to aquatic insects, but bottom dwelling aquatic organisms were limited to tolerant midges in the marsh.

Aquatic Organisms

Only midges were found in the ponar grab samples collected in the marsh. These organisms are generally considered pollution tolerant. No other benthic aquatic insects were noted. The limited bottom dwelling community may be due to marsh water fluctuation (i.e., it may dry up in the summer) or it may be due to elevated concentrations of one or more heavy metals. Zooplankton were present at Stations 1 and 2. *Daphnia* sp. were very abundant at Station 2 nearest the old lagoon discharge where concentrations of copper in the water exceeded the criterion for aquatic life. It may be that these organisms blew in from another part of the marsh where copper was less concentrated. Other possibilities are that organic materials in the water column bound these copper molecules or that hardness and pH conditions created conditions reducing its toxicity. *Daphnia* are generally considered sensitive to relatively low copper concentration (Creal and Basch, 1981).

Only one fish was seen. A mudminnow was present near the outlet from the parking lot and roof runoff drainage system. The fish was dead with no evident cause. Mudminnows are tolerant of a wide variety of environmental conditions.

The presence of a variety of filamentous (*Spirogyra*) green algae, flagellates (*Euglena*) and other algae (*Scenedesmus*) *Oocystis*, *Synedra*, *Oscillatoria* and *Mougeotia*) and macrophytes (*Typha*, *Scirpus*, *Lemna minor*, *Elodea* and *Potamogeton*) indicated that the discharge did not have much impact on these aquatic plants (Table 3).

Literature Cited

Creal, W. and R. Basch. 1981, Water quality-Based Effluent LImits for Heavy Metals and Cyanide, MDNR, 124 p.

Environmental Protection Bureau, Michigan Department of Natural Resources, 1981, Quality Assurance Manual for Water and Sediment Chemistry.

Grant, 1978, Investigation of Hi Mill Manufacturing Treatment Facility, Vicinity of Highland, Michigan, April 26, 1978.

Hesse, J. N., and E. Evans, 1972, Heavy Metals of Surface Water, Sediments and Fish in Michigan. Michigan MDNR, 58 pp.

Sibo, K., 1982. A Hydrogeological Study of the Vicinity of Hi MIll Manufacturing, Highland, Michigan Department of Natural Resources.

Surface Water Quality Division Files for Hi Mill Manufacturing. MDNR.

Survey By: John Wuycheck, Aquatic Biologist
Dave Kenaga, Aquatic Biologist

Lab Analysis By: Environmental Lab

Algal Analysis By: Carey Johnson

Report By: David Kenaga, District Aquatic Biologist
Michigan Department of Natural Resources
Water Quality Surveillance Section
Surface Water Quality Division

Figure 1. Location of ... Company, Oakland County, Michigan, April 26. 1984.

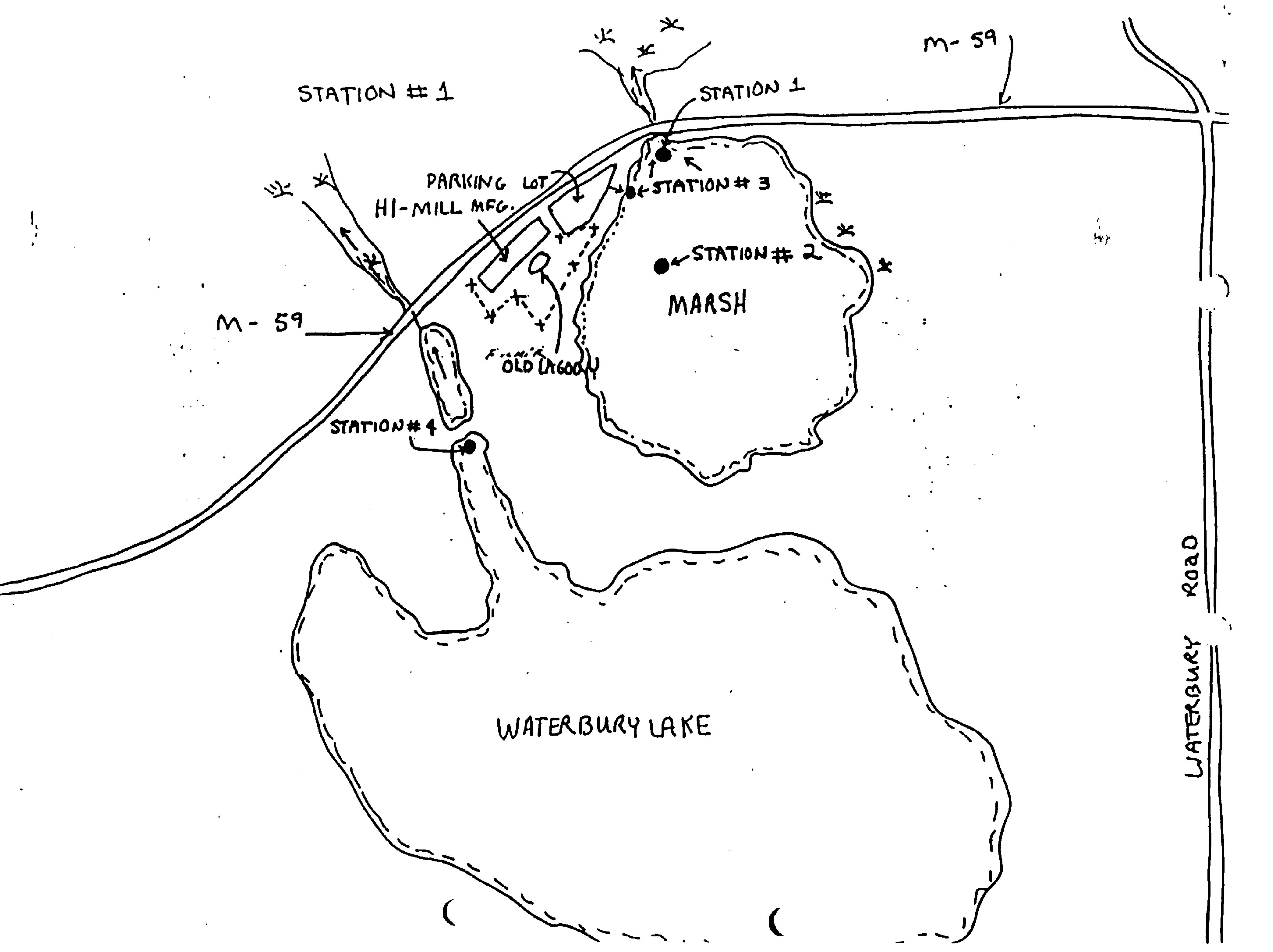


Table 1. Concentrations of selected heavy metals in water in the vicinity of Hi-Hill Manufacturing Company, April 26, 1984. Results in μg/l. (1978 Results from Grant 1978)

Location Sampled	Total Aluminum	Total Arsenic	Total Iron	Total Mercury	Total Zinc	Total Cadmium	Total Chromium	Total Copper	Total Nickel	Total Lead
At M-59 Marsh outlet	<400	<0.5	150	<0.5	23	0.2	2.8	48	<4	2.5
Mid Marsh East of building	<400	<0.4	120	<0.5	22	<0.2	6.5	200	<4	<2.0
Roof and parking lot runoff	964	1.3	914	<0.5	70	0.6	24	560	<4	<2.0
Outlet from Waterbury Lake	-	3.6	-	<0.5	-	<0.2	<2	3	<4	<2.0
Middle of Marsh (1978)	2000	-	-	-	2200	-	10	440	<50	<50

e 2. Concentrations of selected heavy metals in sediments in the vicinity of Hi-Hill Manufacturing Company, April 26, 1984. Results in mg/kg dry weight.

ation Sampled	Total Aluminum	Total Arsenic	Total Iron	Total Mercury	Total Zinc	Total Cadmium	Total Chromium	Total Copper	Total Nickel	Total Lead	Total Manganese	Total % Solids	Total Lithium
M-59 sh outlet	29,200	7.5	19,900	<0.5	1,800	11.0	2,350	10,000	50	269	360	13	-
Marsh t of building	16,100	4.2	15,600	<0.5	1,500	8.5	5,300	5,650	19	84	130	24	90
rking lot and roof runoff	11,890	5.8	17,700	0.7	1,700	11.0	2,240	4,700	18	97	380	32	90
:let from :erbury Lake	7,190	5.5	10,100	<0.5	150	<2.0	50	155	13	91	150	14	15

Table 3. Aquatic plants found in the Marsh, east of Hi-Mill Manufacturing Company, Oakland County, Michigan, April 26, 1984.

Algae	Macrophytes
Spirogyra	*Typha*
Euglena	*Scirpus*
Scenedesmus	*Lemna minor*
Oocystis	*Elodea*
Oscillatoria	*Potamogeton*
Mougeotia	
Synedra	

FISH — GAME FISH

ROUGH FISH

FORAGE FISH

ATIC PLANTS — PERIPHYTON — FILAMENTOUS ALGAE

MACROPHYTES: Typha, Scirpus, Lemna minor, Elodea, Potamogeton

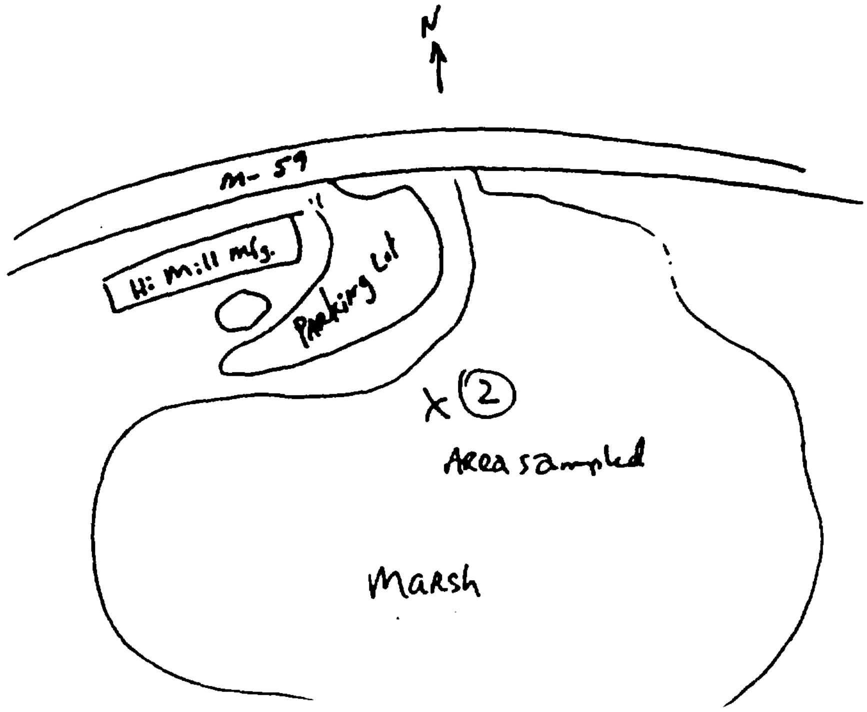
Periphyton and/or filamentous algae covered everything in this area.

STREAMBANK VEGETATION: GRASSES BRUSH HERBACEOUS CONIFERS DECIDUOUS BARREN OTHER ______

MACROBENTHOS QUALITATIVE SAMPLE CHECK LIST (INDICATE DOMINANT GROUPS)

SPONGES	DRAGONFLIES	RATTAILED MAGGOTS
HYDRA	DAMSELFLIES	MIDGES C-A
FLATWORMS	TRUE BUGS	STONEFLIES
ROUNDWORMS	BEETLES	MAYFLIES
LEECHES	AQUATIC CATTERPILLARS	-BURROWERS
WATER MITES	ALDERFLIES	-SWIMMERS
SOWBUGS	HELLGRAMITES	-CLINGERS, SPRAWLERS
IDS	CRANEFLIES	CADDISFLIES
CRAYFISH	NO-SEE-UMS	-FREE LIVING
SNAILS-LIMPETS	BLACKFLIES	-PURSE CASE MAKERS
CLAMS	DEERFLIES	-TUBE CASE MAKERS
AQUATIC EARTHWORMS	MOSQUITOES	-SADDLECASE MAKERS
	SNIPEFLIES	-NET SPINNERS OR RETREATMAKERS

NOTES, ETC. Zooplankton - Abundant in water column



MICHIGAN DEPARTMENT OF NATURAL RESO[illegible]ES
WATER QUALITY DIVISION

BIOLOGY SECTION
STREAM PROBLEM ASSESSMENT

Station Number 3 Investigator(s) Kenaga, Wuycheck

Date 4/ 26/ 84 TIME 1:00 PHOTOGRAPH NUMBER

BODY OF WATER Roof and Parking lot off to marsh SE of Hi-Mill Mfg. LOCATION pipe at east edge of parking lot

COUNTY Oakland T 3N R 7E S 23 TWP Highland

REASON FOR SURVEY Hi-Mill Mfg. Co.

VICINITY LAND USE: Mostly Forest Mostly Urban Mostly Agriculture Other

AVE. STREAM WIDTH 6 in AVE. STREAM DEPTH 1 in. VELOCITY <0.4 fps STREAM km

STREAM SHADING: Open Partly Open Shaded STREAM TYPE: Coldwater Warmwater

WATER TEMP. – °C AIR TEMP. 65 °F WEATHER: Sunny—Partly Cloudy—Cloudy—Rainy DAM u/s: Yes No km

CHANNELIZED: Yes No CHANNEL EROSION: None — Slight — Moderate — Severe HIGH WATER MARK 6 in

SECCHI DISC TRANS: – m TURBIDITY: Clear— Slightly Turbid — Turbid — Opaque WATER COLOR

WATER ODORS: Normal Sewage Petroleum Chemical Other

SURFACE OILS: None Slick Sheen Globs Flecks

SEDIMENT ODORS: Normal Sewage Petroleum Chemical Anaerobic Other

SEDIMENT OILS: Absent Slight Moderate Profuse

DEPOSITS: Sludge Sawdust Paperfiber Sand Relict Shells Other

ARE THE UNDERSIDES OF STONES WHICH ARE NOT DEEPLY IMBEDDED IN SUBSTRATE BLACK? YES NO

SUBSTRATE TYPE	FLOW VELOCITY m/sec	CHARACTERISTICS OR SIZE	PERCENT IN SAMPLING AREA
BOULDERS* ____	>1.2 (>3 fps)	256 mm (10") dia.	
RUBBLE* ____	>0.6 (>2 fps)	64-256 mm (2.1-10") dia.	
GRAVEL* ____	>0.3 (>1 fps)	2-64 mm (0.1-2.5") dia.	
SAND	>0.2 (>0.7 fps)	0.06-2.00 mm dia. Gritty texture	
SILT	>0.12 (>0.4 fps)	0.004-0.006 mm dia.	
MUCK-MUD	<0.12 (<0.4 fps)	black, very find organic	10

*IMBEDDEDNESS: 0 = NONE 1 = 1/3 OR LESS 2 = 2/3 OR MORE

SUBSTRATE TYPE	CHARACTERISTICS OR SIZE	PERCENT IN SAMPLING AREA
CLAY	Slick texture	
MARL	Grey, shell fragments	
DETRITUS	Sticks, wood, coarse plant materials	70
FIBROUS PEAT	Partially decomposed plant material	
PULPY PEAT	Finely divided plant material, parts indistinguishable	10
LOGS & STICKS		

BIOTA:

PHYTOPLANKTON	~~0~~	1	2	3	4	SLIMES	0	1	2	3	4
PERIPHYTON	0	1	2	3	4	ZOOPLANKTON	0	1	2	3	4
FILAMENTOUS ALGAE	0	1	2	3	4	MACROINVERTEBRATES	0	1	2	3	4
MACROPHYTES	0	1	2	3	4	FISH	0	1	2	3	4

1 - Sparse 2 - Moderate 3 - Abundant 4 - Profuse

FISH

GAME FISH

ROUGH FISH

FORAGE FISH - one dead mud minnow near parking lot runoff site

QUATIC PLANTS

PERIPHYTON

FILAMENTOUS ALGAE

MACROPHYTES

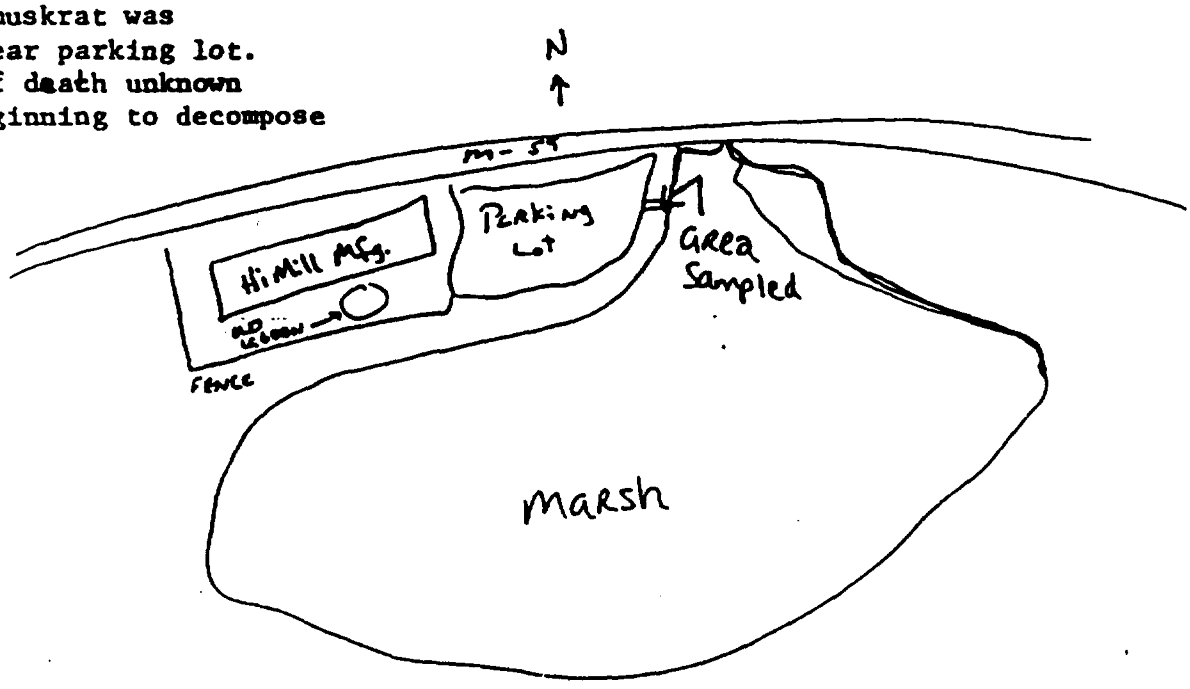
STREAMBANK VEGETATION: GRASSES BRUSH HERBACEOUS CONIFERS DECIDUOUS BARREN OTHER______

MACROBENTHOS QUALITATIVE SAMPLE CHECK LIST (INDICATE DOMINANT GROUPS)

SPONGES	DRAGONFLIES	RATTAILED MAGGOTS
HYDRA	DAMSELFLIES	MIDGES
FLATWORMS	TRUE BUGS	STONEFLIES
ROUNDWORMS	BEETLES	MAYFLIES
LEECHES	AQUATIC CATTERPILLARS	-BURROWERS
WATER MITES	ALDERFLIES	-SWIMMERS
SOWBUGS	HELLGRAMITES	-CLINGERS, SPRAWLERS
SCUDS	CRANEFLIES	CADDISFLIES
AYFISH	NO-SEE-UMS	-FREE LIVING
SNAILS-LIMPETS	BLACKFLIES	-PURSE CASE MAKERS
CLAMS	DEERFLIES	-TUBE CASE MAKERS
AQUATIC EARTHWORMS	MOSQUITOES	-SADDLECASE MAKERS
	SNIPEFLIES	-NET SPINNERS OR RETREATMAKERS

NOTES, ETC. No macroinvertebrates in small trickel

A dead muskrat was
noted near parking lot.
Cause of death unknown
body beginning to decompose



FISH — GAME FISH

ROUGH FISH

FORAGE FISH - minnows noted in shallow areas

AQUATIC PLANTS — PERIPHYTON — FILAMENTOUS ALGAE

MACROPHYTES: Scirpus, Typha, Chaga, Potamogeton, Nuphar, Nymphea

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STREAMBANK VEGETATION: GRASSES BRUSH HERBACEOUS CONIFERS DECIDUOUS BARREN OTHER______

MACROBENTHOS QUALITATIVE SAMPLE CHECK LIST (INDICATE DOMINANT GROUPS)

SPONGES	DRAGONFLIES	RATTAILED MAGGOTS
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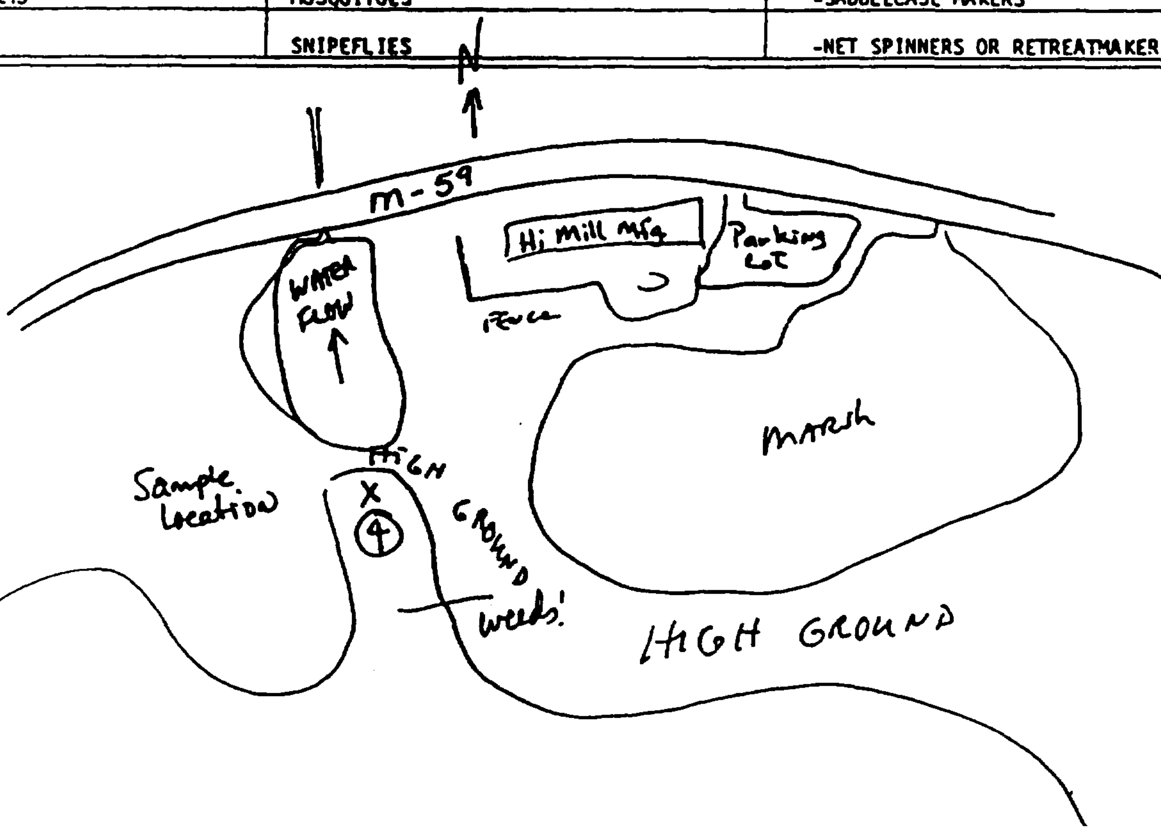
WATER MITES	ALDERFLIES	-SWIMMERS
SOWBUGS	HELLGRAMITES	-CLINGERS, SPRAWLERS
SCUDS	CRANEFLIES	CADDISFLIES
CRAYFISH	NO-SEE-UMS	-FREE LIVING
SNAILS-LIMPETS	BLACKFLIES	-PURSE CASE MAKERS
CLAMS	DEERFLIES	-TUBE CASE MAKERS
AQUATIC EARTHWORMS	MOSQUITOES	-SADDLECASE MAKERS
	SNIPEFLIES	-NET SPINNERS OR RETREATMAKERS

NOTES, ETC.



MICHIGAN DEPARTMENT OF NATURAL RESOURCES
WATER QUALITY DIVISION

BIOLOGY SECTION
STREAM PROBLEM ASSESSMENT

Station Number 4 Investigator(s) Kenaga, Wuycheck

Date 4 / 26 / 84 TIME 2:00 PHOTOGRAPH NUMBER

BODY OF WATER Waterburg Lake LOCATION at outlet

COUNTY Oakland T3N R7E S 23 TWP HIGHLAND

REASON FOR SURVEY Hi-Mill Mfg. Co.

VICINITY LAND USE: Mostly Forest Mostly Urban Mostly Agriculture Other Park

AVE. STREAM WIDTH Lake m AVE. STREAM DEPTH 5 ft. VELOCITY – ms STREAM km

STREAM SHADING: Open Partly Open Shaded STREAM TYPE: Coldwater Warmwater

WATER TEMP. – °C AIR TEMP. 65°F WEATHER: Sunny–Partly Cloudy–Cloudy–Rainy DAM u/s: Yes No

CHANNELIZED: Yes No CHANNEL EROSION: None — Slight — Moderate — Severe HIGH WATER MARK 2

SECCHI DISC TRANS: 5 ft. TURBIDITY: Clear— Slightly Turbid — Turbid — Opaque WATER COLOR clear

WATER ODORS: Normal Sewage Petroleum Chemical Other

SURFACE OILS: None Slick Sheen Globs Flecks

SEDIMENT ODORS: Normal Sewage Petroleum Chemical Anaerobic Other

SEDIMENT OILS: Absent Slight Moderate Profuse

DEPOSITS: Sludge Sawdust Paperfiber Sand Relict Shells Other

ARE THE UNDERSIDES OF STONES WHICH ARE NOT DEEPLY IMBEDDED IN SUBSTRATE BLACK? YES NO

SUBSTRATE TYPE	FLOW VELOCITY m/sec	CHARACTERISTICS OR SIZE	PERCENT IN SAMPLING AREA
BOULDERS* ___	>1.2 (>3 fps)	256 mm (10") dia.	
RUBBLE* ___	>0.6 (>2 fps)	64-256 mm (2.1-10") dia.	
GRAVEL* ___	>0.3 (>1 fps)	2-64 mm (0.1-2.5") dia.	
SAND	>0.2 (>0.7 fps)	0.06-2.00 mm dia. Gritty texture	
SILT	>0.12 (>0.4 fps)	0.004-0.006 mm dia.	
MUCK-MUD	>0.12 (>0.4 fps)	black, very find organic	20

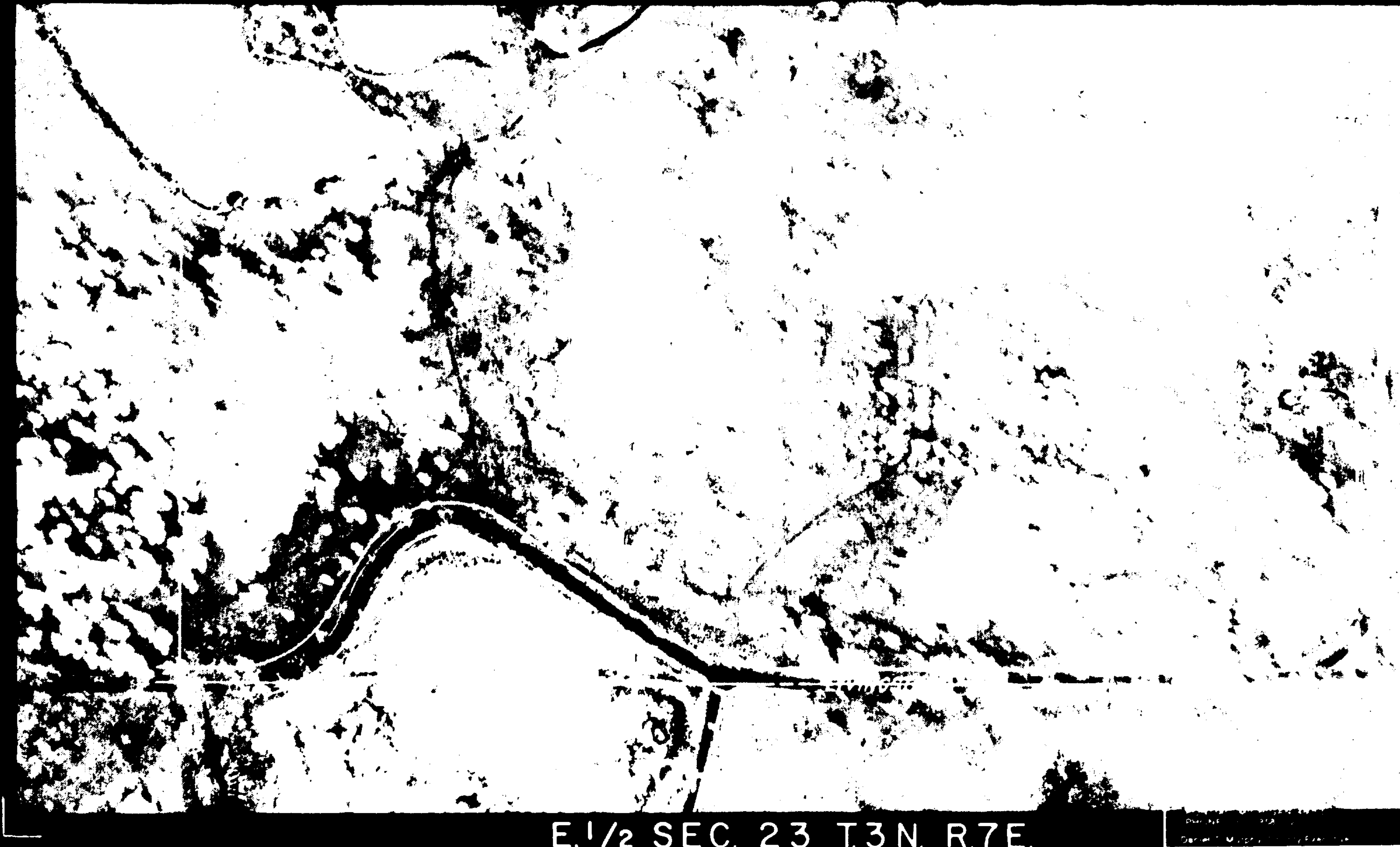
*IMBEDDEDNESS: 0 = NONE 1 = 1/3 OR LESS 2 = 2/3 OR MORE

SUBSTRATE TYPE	CHARACTERISTICS OR SIZE	PERCENT I SAMPLING AR
CLAY	Slick texture	
MARL	Grey, shell fragments	
DETRITUS	Sticks, wood, coarse plant materials	60
FIBROUS PEAT	Partially decomposed plant material	
PULPY PEAT	Finely divided plant material, parts indistinguishable	20
LOGS & STICKS		

BIOTA:

PHYTOPLANKTON	~~0~~	1	2	3	4
PERIPHYTON	0	1	2	3	4
FILAMENTOUS ALGAE	0	1	2	3	4
MACROPHYTES	0	1	2	3	4
SLIMES	0	1	2	3	4
ZOOPLANKTON	0	1	2	3	4
MACROINVERTEBRATES	0	1	2	3	4
FISH	0	1	2	3	4

2 - Moderate 3 - Abundant 4 - Profuse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204
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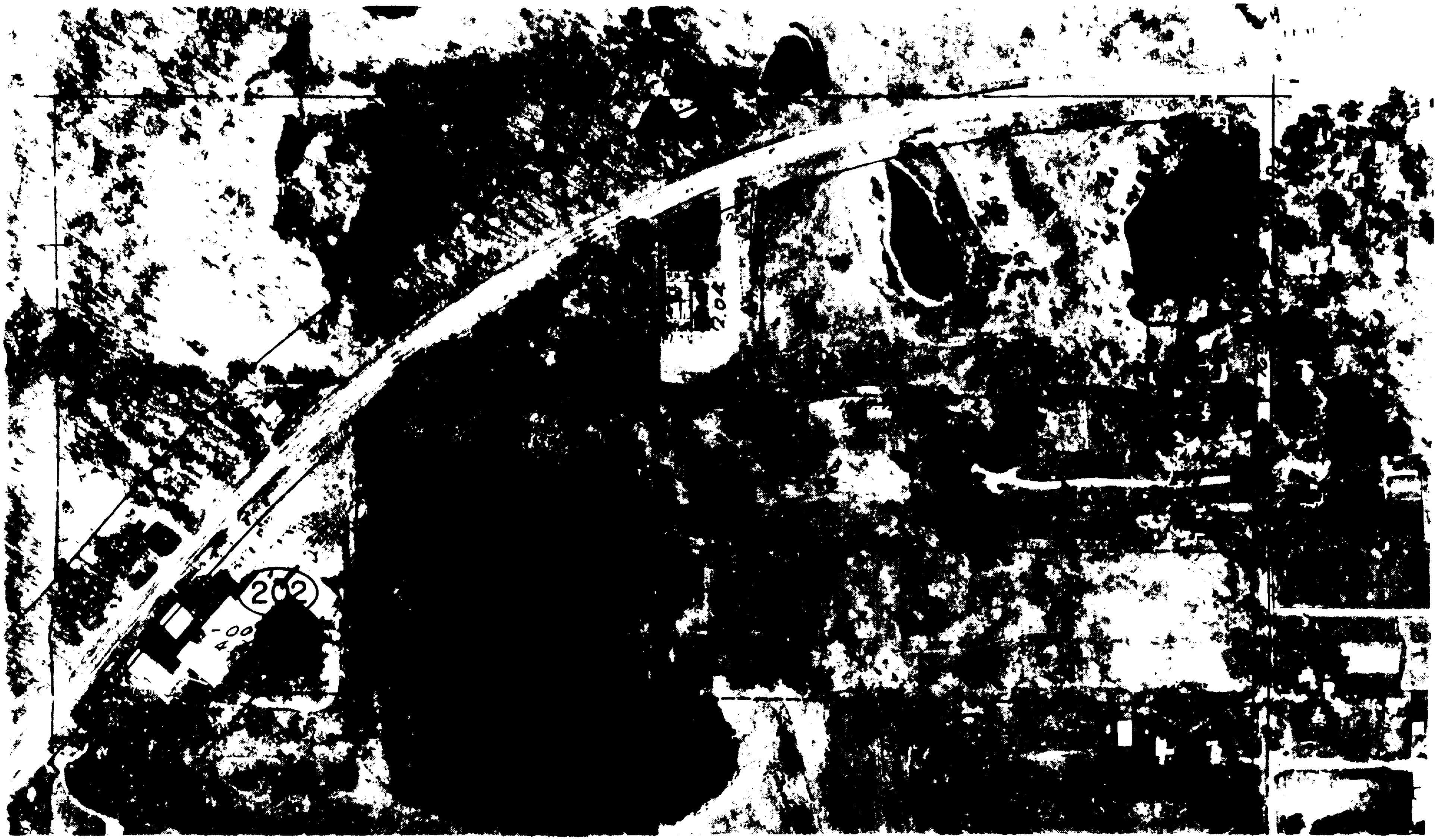
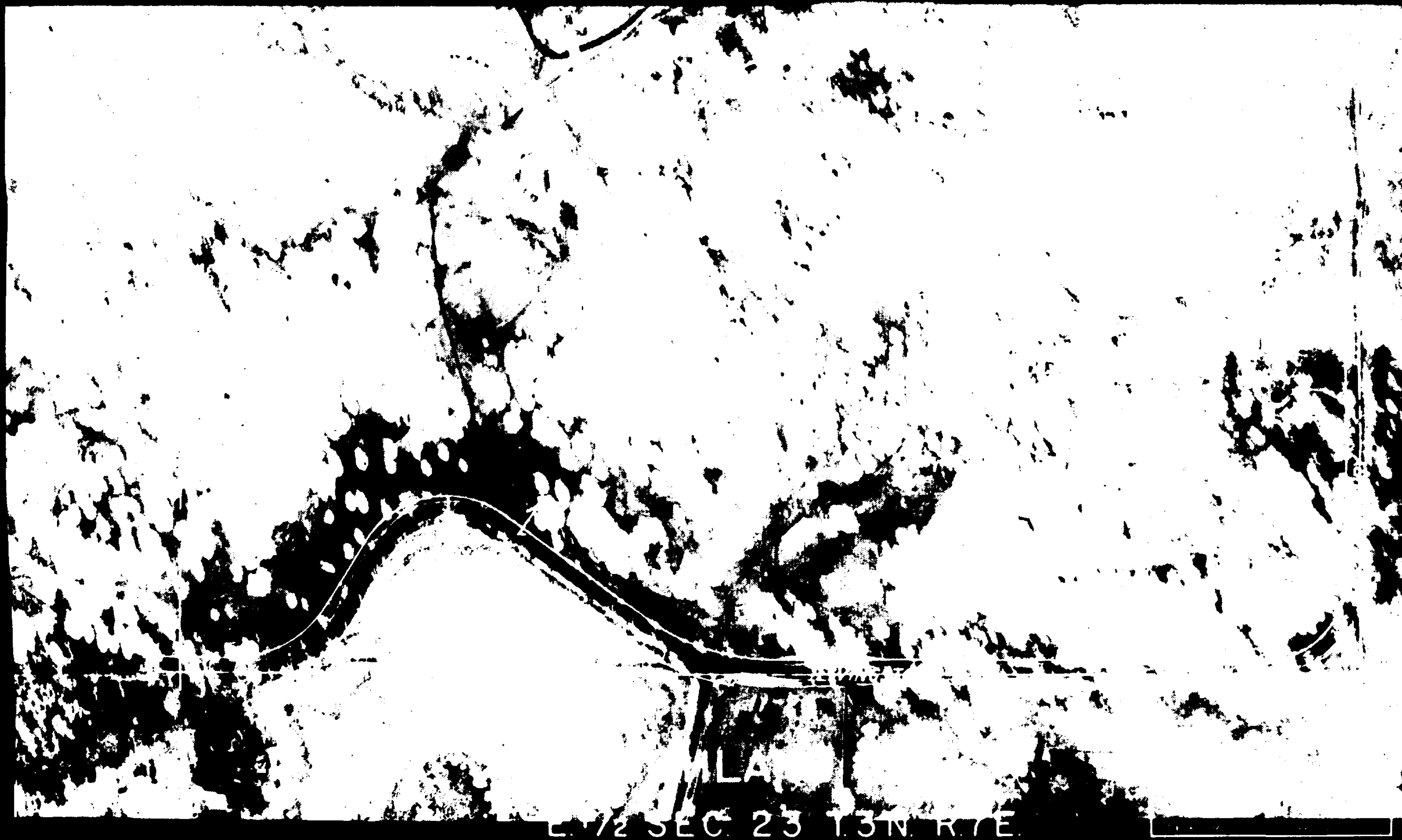
1980




9
SCALE 1" = 200'
E. 1/2 SEC. 23 T.3N. R.7E.
11 - 23
PLATE III
Hi-Mill Remedial Investigation
Draft RI Report
June 21, 1990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E. 1/2 SEC. 23 T.3N. R.7E.

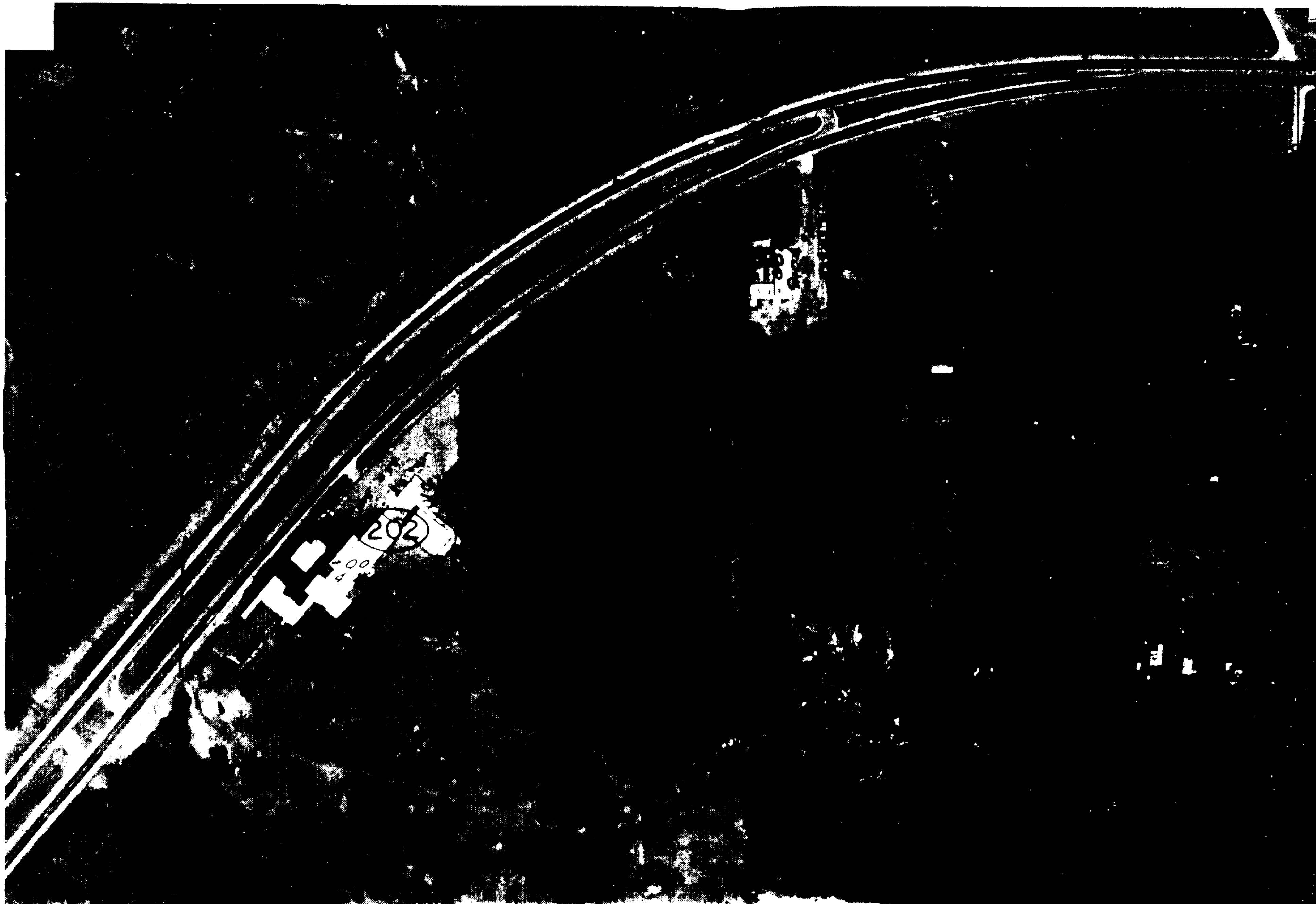
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PLATE II
Hi-Mill Remedial Investigation
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